The MINING CONGRESS JOURNAL

Volume 15 SEPTEMBER, 1929 No. 9

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Some Trends in Industry

Annual Western Division Meeting at Spokane

A Mining School in a Great Mining and Metallurgical Center

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New Plant and Equipment at Constitution Mine

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Drainage and Pumping in Windber Field

Longer Underground Haulage

Power Problems in Coal Production

Mining Pitching Coal Seams

Rock Disposal in Anthracite Mining

Contributors:

Alfred Kauffmann, R. B. Ketchum, H. Speight, W. D. Turnbull, William P. White, G. B. Southward, A. H. Truax, K. A. Spencer, E. J. Newbaker, Newell G. Alford, R. M. Watt, L. D. Anderson, George Watkin Evans, E. P. Humphrey, J. Latimer Lee.

Cutting Cost per Ton of Production

O-B TROLLEY TAP, FORM 3

The simplicity of this tap is startling. It has only five parts. The fuse is held by a combination clip and butt contact, and can be renewed in a jiffy —without pliers or screwdriver. Also, it is impossible to crush or otherwise damage the fuse in any way. Tap is made in two styles: Hook type as shown above—Catalog No. 15821. Clamp type—Catalog No. 15825.

SERVICED to them, "hand-high" these men are saved the back breaking operation of stooping over to pick up the castings they are "finishing". The result is more human energy left over to do a better, bigger job. Turned back, this saving makes possible such additional processes of refinement as heat treating malleable iron, extra quality hot dip galvanizing and pyrometric control of annealing furnaces, in short, better products at no additional cost to the customer.

Remember When Your Dollars Went up in Smoke?

MOTORS running with partially shorted armatures; motors grounded; motor windings and trailing cables over-loaded and red-hot—remember the times when this has happened? And do you remember how "it hurt" to pull these machines off the line? to send them back to the shop for new or rewound armatures? to replace four or five feet of burned-out trailing cable with new? And think how these hundreds of dollars which went up in smoke could have been saved if only a few dollars had been spent for fuse protection in the circuits.

Of course you will not be without this protection in the future. Like thousands of others, you will take advantage of the protection which O-B Fused Trolley Taps give to men, motors, and production. These O-B Taps place protection ahead of the cable, preventing cable and motor burn-outs; and afford a gratifying factor of safety to the men against the possibility of a spark igniting gas at the face.

If you have no money to burn, you will be interested in learning more in general about the application of O-B Trolley Taps; and in learning more in particular about the many cost and labor-saving features of the O-B Fused Trolley Tap, Form 3. This Form 3 Tap is new and advanced in design. Ask your O-B representative for the complete details of construction, or write:

Ohio Brass Company, Mansfield, Ohio
Canadian Ohio Brass Co., Limited
Niagara Falls, Canada
105 8M

Ohio Brass Co.

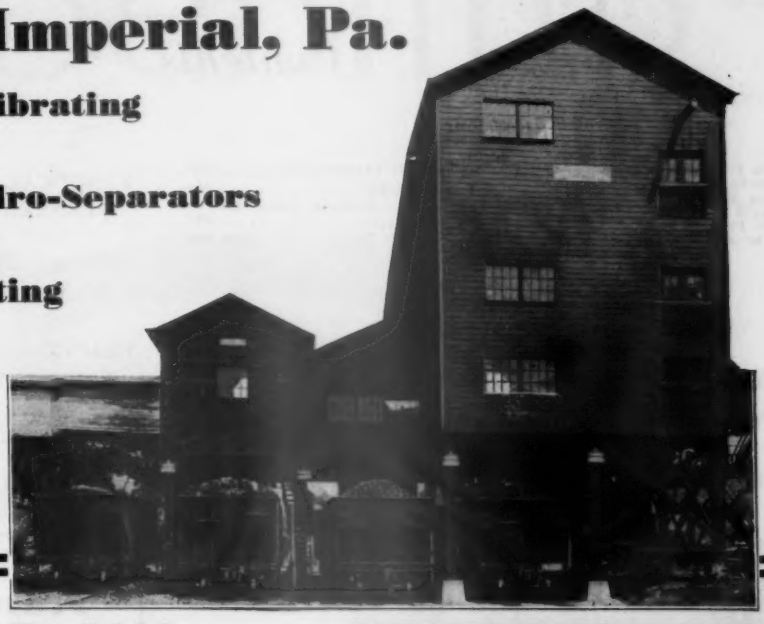
NEW YORK PHILADELPHIA CHICAGO BOSTON PITTSBURGH ST. LOUIS ATLANTA SAN FRANCISCO CLEVELAND LOS ANGELES

PORCELAIN INSULATORS
LINE MATERIALS
RAIL BONDS
CAR EQUIPMENT
MINING MATERIALS
VALVES

Clinton Block Coal Co.'s Rebuilt Tipple at Imperial, Pa.

— uses Arms Vibrating Screens,

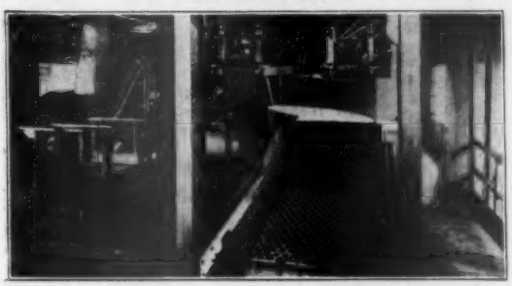
Menzies Hydro-Separators and Arms Air Concentrating Tables



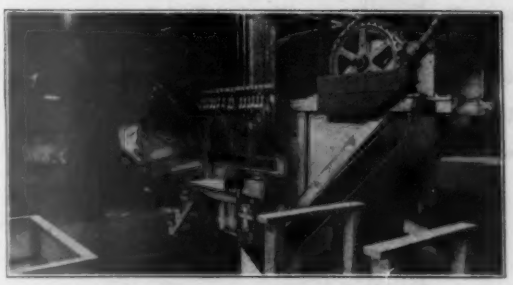
An exterior view of the Clinton Block Coal Company's Tipple at Imperial, Pennsylvania —rebuilt to produce clean coal profitably with the RandS Method of Coal Cleaning.

Below, the elevator-conveyor from the Menzies Hydro-Separator discharges onto the Triple Deck Arms Horizontal Vibrating Screen shown in the foreground. One hundred tons of coal per hour are dewatered and sized to Egg, Pea and Nut over this screen.

Above, the Menzies Hydro-Separator installed in the Clinton Block Coal Company's Plant. The elevator-conveyor at the top of the separator tank handles refuse to a discharge chute shown behind the electrical panel.



At right, two Arms Air Concentrating Tables (shown at left of illustration)—one is used for dry cleaning 50 tons hourly of ½"x0" slack, the other for recleaning the ¼"x0". Dust hoods over the cleaning tables are connected to a cyclone type dust collector.



Write today for copies of Bulletin Nos. 110, 117, 121, 122 and 123. They deal with the economical cleaning and preparing of coal for market.

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The MINING CONGRESS JOURNAL

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E. R. COOMBES, *Editor*

GUY N. BJORGE, *Associate Editor*
M. W. KRIEGH, *Assistant Editor*
ERNEST H. PULLMAN, *Legislative Editor*
WALTER LUKEI, *News Editor*
NEWELL G. ALFORD, *Associate Editor*
F. E. PRIOR, *Art Editor*
J. M. HADLEY, *Production Manager*
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In every mining property wire rope plays a most important part in the cost per ton of mining and handling the coal.

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Dry Floors Promote Mining Efficiency

.... and LaBour Pumps keep them dry!

Efficient mine operation demands that all working floors be kept dry. Neither workmen nor machinery can perform their tasks efficiently when "sloshing" around in water. Furthermore, the deteriorating effect of corrosive mine water has ruined many a costly piece of equipment. LaBour Self-Priming Centrifugal Pumps are especially effective in gathering operation and provide a dependable and economical means of keeping mine floors dry under normal or emergency conditions. They prime themselves and actually pump air so that the water is automatically gathered without attention at the sump. No foot or check valves are required, and water may be gathered at different levels simultaneously from depths as low as twenty feet.

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Let us tell you more about LaBour sump installations, and how they have reduced operating costs and saved equipment in many well-known mines. Your name and address will bring you complete information by return mail.

The LaBour Gathering Valve, of compact design, automatically seals the suction line when the water is low, thus enabling the pump to gather from several sumps at the same time, and at different elevations. Acid-proof and non-corrosive.

The LaBour Company, Inc., Elkhart, Indiana

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Skinny says—Jeffrey 29-C *Arcwall* Is "*Last Word*"

Skinny: Here's one I ain't saw before.

Bill: Yea, that's for spooling the cable on the reel, an' it's a good one, too. It holds up the cable good so that there ain't much danger of runnin' over it. This machine has sure got about everything on it that is needed, an' you can work it just as good goin' ahead as backin' up.

Skinny: Talkin' about backin' up, I was takin' the missus for a little ride in the flivver las' night an' when we came to that little culvert over Greasy Creek, that big wop Tony pulled on the culvert just as I did, an' there wasn't room for both of us to pass. Tony he yelled, "I don't back up fur no dern fool!"

Bill: What did you do then?

Skinny: I put her in reverse an' backed up, an' said "Well, I does!"

We will be glad to send you a complete description of the many features of the Jeffrey 29-C Arcwall Machine

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Detonators should not be stored in the same magazine with black powder or dynamite.

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Gentlemen: Please send me the following:

☐ Other advertisements of this series which are suitable for bulletin board posting.

☐ Large linen poster of explosives handling and use rules.

☐ Best Practices Handbook

☐ 1928 *Explosives Engineer* index of drilling and blasting articles.

Name..... Address.....

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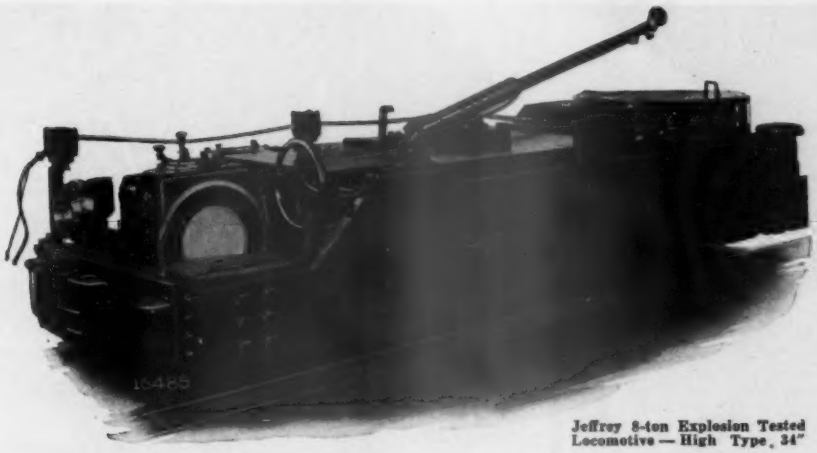


Jeffrey 8-ton Explosion Tested Locomotive — High Type, 34"

A Totally Enclosed Explosion Tested *Gathering Locomotive*

All the qualities which the name "Jeffrey" entitles you to expect in a mine locomotive are embodied in this added achievement of Jeffrey Engineers in gathering locomotive design.

Low type only 26" high. High type 34" high.

All electrical parts enclosed in compartments tested against explosion. Where accessibility is desirable, it is obtained through screw type hand holes. All wiring carried in heavy air hose, which terminates in cable shields, bearing on explosion tested compartments.

Vertical cable reel developed especially for this type. Reel motor with collector rings have their own explosion tested compartment.

Reel motor—of the type to stand it—is thrown directly on the line without resistance, hence there is always power to reel, regardless of voltage.

Cable runs through a trough which extends length-wise of the locomotive, under covers, so cable cannot come in contact with metal parts.

Cable circuit—full metallic—no ground—interlocking transfer switch provides that motors run only in series when on cable.

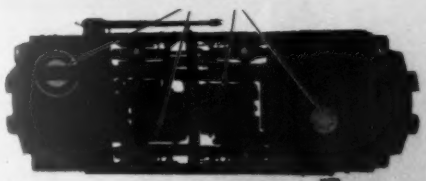
Control is either progressive series parallel or series and parallel-manual or contactor.

Steel slab frame roller bearings—two powerful motors.

The Jeffrey line of mine locomotives is complete, let us send you literature.

Jeffrey 8-ton Explosion Tested Locomotive — Low Type — only 26" high.

Screw hand hole covers provide quick accessibility wherever inspection is necessary



Top view showing quality of construction and accessibility

Controller with hand hole open showing type of explosion tested chamber. Controller shown is arranged for contactor control. If desired controller arranged for manually operated control can be furnished.

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WHEN days grow shorter—when dark hours crowd out productive operation—speed up your job with a night shift.

Carbic Flood Lights are powerful, portable units that supply clear white perfectly diffused light. They are rugged pieces of equipment built to serve you night after night.

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Extend Your Working Day With
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Mr. S. S. Miller, the president of the company, was engaged in the making of bicycle and carriage tires when those two articles constituted the main output of rubber manufacturers. From then until now, he has been continuously engaged in various branches of the rubber industry, and has always adhered to the best standards for both materials and methods of treatment.

A full line of balloon, high-pressure, truck and bus tires, are manufactured; also red and gray tubes and various repair material accessories. These products are generally known and have a nation-wide distribution.

In the factory itself, about 500 workers are employed.

City water is used for boilers and hydraulic systems.

The use of pipe in such a plant is extensive and in some parts, the service is very exacting. Only a material highly immune to corrosion could give satisfactory service. The use of Byers Pipe of genuine wrought iron is a testimonial of merit in the pipe and a proof of discrimination in those responsible for factory maintenance.

Akron, Ohio, plant of the Mohawk Rubber Company. Byers Pipe used for water supply and other lines.

R. C. GUNTHER, *Factory Manager*
J. A. PECKHAM, *Plant Engineer*

A. M. BYERS COMPANY
Established 1864 Pittsburgh, Pa.
Distributors in All Jobbing Centers

BYERS PIPE
GENUINE WROUGHT IRON

Bethlehem Steel Ties

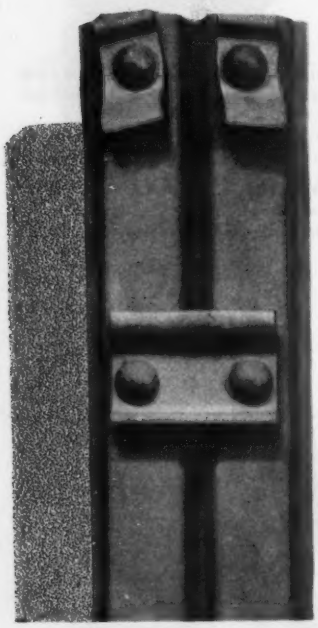
keep the coal cutter on the track

Efficient operation at the face requires track that is rigid enough to withstand the heavy pounding of the cutting machine without spreading or rolling over of the rails.

Bethlehem Standard Steel Mine Ties hold the rails securely, keeping them true to gage and providing a firm base for the machines to rest upon. Derailments during cutting and loading are eliminated, the load rate greatly increased, and uninterrupted service at the face assured by using these reliable steel ties.

In transferring operations from room to room, the advantages of Bethlehem Standard Steel Ties are apparent. The removal of track and relaying in new locations is easy and rapid, and the general efficiency of the mining cycle is increased.

Bethlehem Standard Steel Ties, used in this room, prevent derailment of the cutter at the face, and increase the load rate.



The Bethlehem Standard Steel Mine Tie is made in one piece of high-grade rolled steel. The tie is complete in itself and is made to fit track of any gage. One side of the rail base fits under a broad, rugged steel clip, while two movable locking clips are provided for holding the other side of the rail. The ties are shipped with locking clips open, ready for immediate laying.

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Bethlehem Steel Export Corporation, 25 Broadway, New York City, Sole Exporter of our Commercial Products.

BETHLEHEM

TIES FOR EVERY LOCATION IN THE MINE

◆◆ BEHIND THE PYRAMIDS—9 ◆◆

N C C

20 days in a unique furnace

View of part of a ring furnace

THE "green" blocks as they come from the moulding machines are entirely unsuitable for use as brushes, though they have gone through eight major manufacturing operations, and innumerable minor ones, all under accurate scientific control. The next operation is baking. This is done in an unusual ring-type furnace, of exclusive design. The blocks, or in the case of small brushes, the pre-formed brushes themselves, are packed in the furnace, which is then fired by gas to a high temperature, carefully kept within close limits. The entire operation takes about 20 days. During it, the pitch binder is carbonized, the blocks and brushes made mechanically strong, and the material given the proper degree of electrical conductivity.

This unusual ring furnace is so arranged as to make continuous operation possible. All operations necessary to this process—loading, heating, firing, cooling, unloading—are conducted continually. In design, in efficiency, and in closeness of temperature control this furnace is most unusual, in fact, unique in brush manufacture.

We feel that our pride in it is fully justified by its results.

Time and money are saved by this furnace, which savings are passed along to you. In addition, better quality brushes are made possible, with that degree of uniformity for which National Pyramid Brushes are famous.

An interesting moving picture film illustrating in detail the processes used in the manufacture of carbon brushes will gladly be shown on request to any organization of engineers or students.

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide UCC *and Carbon Corporation*

Carbon Sales Division — SILVER STRAND CABLE — Cleveland, Ohio

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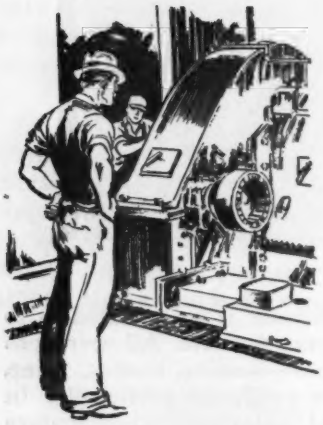
KEYSTONE Lubricants *cost you less to buy!*

Because Keystone Lubricants go so much further than ordinary lubricants, because they stand up under terrific heat and pressure when other lubricants break down, your lubrication bill will be *less* with Keystone Greases than with any other type of lubricant. *A test on your own equipment will prove this!*



Yet you get *more*, far more, than just economy in Keystone Grease. You get a valuable *extra* protection to costly equipment which no "cheaper" lubricant can possibly offer.

You will have less repairs, less shut-downs, and smaller lubrication bills if you use Keystone Lubricants.

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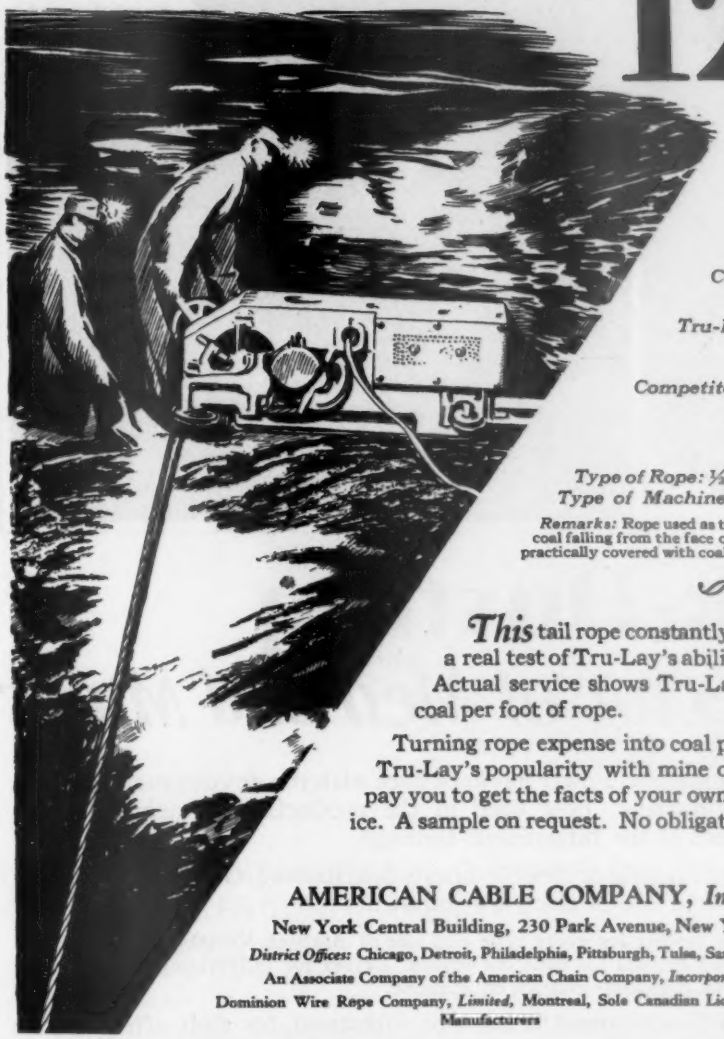
7000 *tons becomes* 12000 *tons*



Company: A Coal Producing Company

Rope Service

Tru-Lay: Average Service: 5 machines—12,729 tons
Maximum Service: 5 machines—average 19,000 tons
Competitor's: Average Service: 5 machines — 7,567 tons
Maximum Service: 5 machines — average 10,100 tons

Rope Data

Type of Rope: ½" Improved Plow Steel
Type of Machine Rope used on: Coal cutting machine

Remarks: Rope used as tail rope which gives considerable trouble due to coal falling from the face on the cutter-bar and on the machine. Rope practically covered with coal all the time.

This tail rope constantly covered with coal, offered a real test of Tru-Lay's ability to stand punishment. Actual service shows Tru-Lay produced 70% more coal per foot of rope.

Turning rope expense into coal profits accounts for Tru-Lay's popularity with mine operators. It will pay you to get the facts of your own wire rope service. A sample on request. No obligation.

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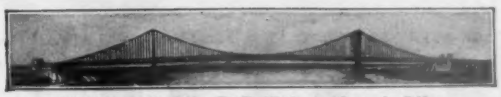
An Associate Company of the American Chain Company, *Incorporated*
Dominion Wire Rope Company, *Limited,* Montreal, Sole Canadian Licensed Manufacturers

PREFORMED WIRE ROPE

TRADE **TRU-LAY** MARK

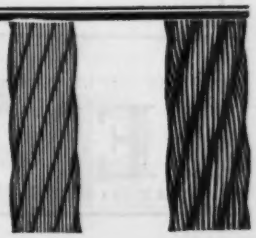
(Reg. U. S. Pat. Off.)

Detroit International Bridge



Philadelphia-Camden Bridge, The World's Greatest Suspension Bridge

Mt. Hope Bridge, Bristol, R. I.



American Cable is used on the World's Greatest Bridges

Rock-dusting machine with 3-hp. G-E motor. Manufactured by Stewart Machinery Co., Birmingham, Ala

Rock-Dusting
Modern Protector of Men and Mines

G-E Motorized Power has kept pace with the development of rock-dusting, now used in the production of nearly one-third of the bituminous tonnage.

For fixed-nozzle or flexible-nozzle distributors, G.E. builds a complete line of electric equipment:

Fan motors for every type and size of machine. Variable-speed motors for dust conveyors. Drives for pulverizing mills. Adequate control equipment.

This G-E equipment is built to withstand, for shift after shift, the gruelling service demanded of rock-dusting machines. Bearings and moving surfaces are protected from the abrasive and clogging action of fine dust. Consult your nearest G-E office for complete electric equipment for rock-dusting.

Apply the proper G-E motor and the correct G-E controller to a specific task, following the recommendations of G-E specialists in electric drive, and you have G-E Motorized Power. Built in or otherwise connected to all types of industrial machines, G-E Motorized Power provides lasting assurance of performance that builds confidence.

Motorized Power
–fitted to every need

200-272

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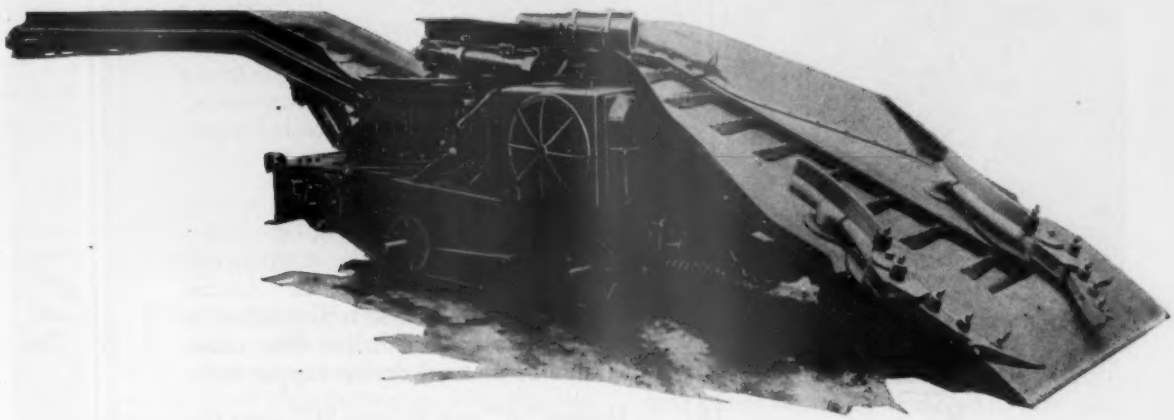
GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

LOADING RECORDS

are being made in every coal district by Joy Loaders. Notice how important a part they play in the Cincinnati Coal Convention papers.



A FEW OF THE MANY TIMES JOYS WERE MENTIONED THIS YEAR

"The first of June, 1925, one 5-BU Joy Loader was started * * * June 1, 1927, we purchased eight 5-BU Joy Loaders."

"The general plan of operation on development work is to give each Joy Loader not less than twelve entries * * *."

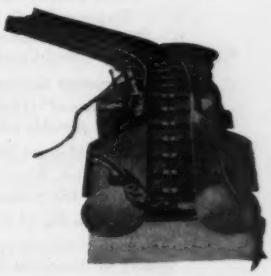
"All entry and other narrow work is driven with the model 5-BU Joy Loaders."

" * * * two type 5-BU Joy Loading Machines being used * * *."

"During 1928 and 1929 Joy Loading Machines have been in operation * * *."

A NEW JOY NOW FOR LOW COAL

The new 7-BU Joy Loader is a compact and flexible machine developed for use in low coal. This loader opens new opportunities for mechanization of low seams. Guaranteed to load two tons per minute.



JOY LOADERS

JOY MANUFACTURING CO., FRANKLIN PENNA

ANACONDA
from mine to consumer

Other Anaconda Wire and Cable Products Used in Mining Operations

Copper Wire
Solid or Stranded
Bare or Weatherproof
Rubber Covered (Durawire*)

Power Cables
Power or V. C. Insulated
Lead Sheathed
Braid Covered

Locomotive Gathering Cables
Duracord* (Heavy duty portable cord)

Magnet Wire
Enameled, cotton covered
silk covered

*Trade-marks Reg. U. S. Pat. Off.

The high conductivity and uniform quality of Anaconda Metals are the result of the coordinated supervision by a single organization of every process from ore to finished product.

Where continuity of service is essential

ANACONDA TROLLEY WIRE

ANACONDA Trolley Wire is used in many of the largest mines throughout the country, because the engineers in charge of operation have learned to rely on it for dependable, *uninterrupted* service.

Anaconda Trolley Wire is tough, strong and durable. Its conductivity is unexcelled because it is made of Anaconda Electrolytic Copper—over 99.9% pure.

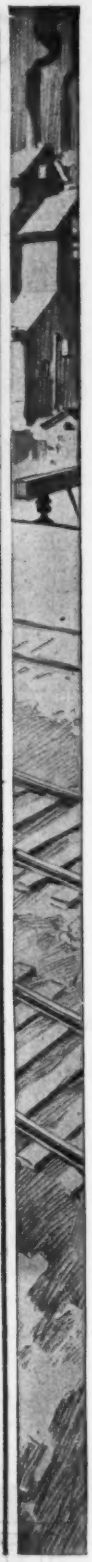
Where the most durable trolley wire is required, and for permanent lines, Anaconda Wire & Cable Co. recommends Hitenso "A" and Hitenso "C." Actual tests have proved these trolley wires to be from two and one-half to three times as durable as hard drawn copper wire.

Hitenso "A" and Hitenso "C" meet the physical requirements of the A. S. T. M. Specifications for Medium Strength Bronze and High Strength Bronze respectively, but exceed the required conductivity by 15%.

Seven modern wire mills offer a coast-to-coast service unequalled for promptness and dependability. Complete information concerning the physical properties of Anaconda Trolley Wire is contained in Bulletin B-11, sent free upon request.

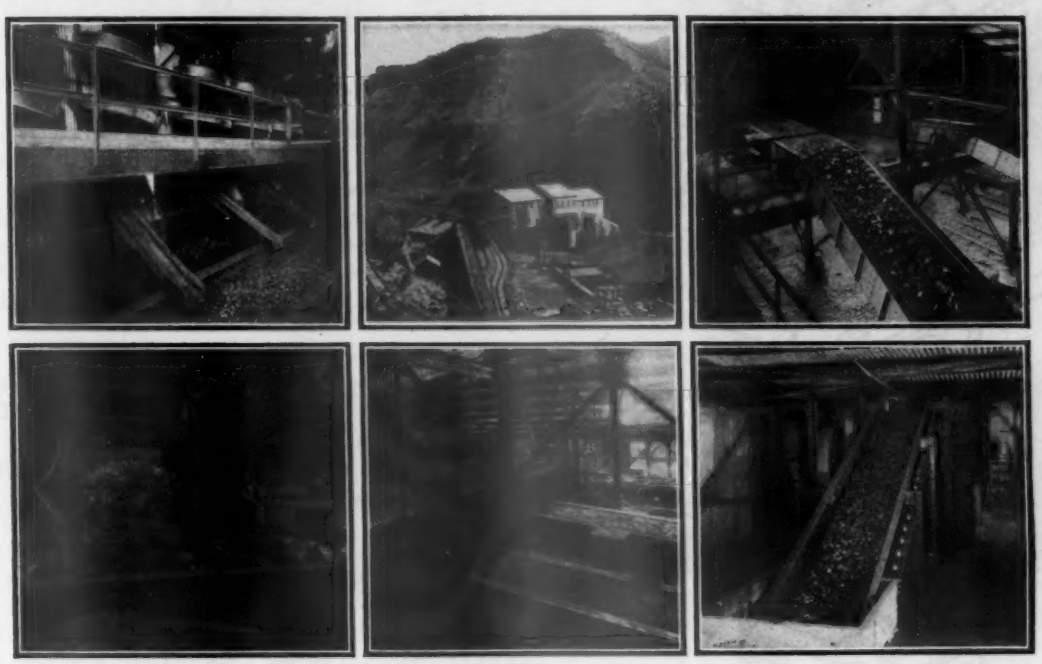
ANACONDA WIRE & CABLE CO.

General Offices: 25 Broadway, New York
Chicago Office: 111 West Washington St.
Exclusive Selling Agent for Wire and Cable Products of
THE AMERICAN BRASS COMPANY



ANACONDA WIRE PRODUCTS

"Excellent preparation" has enabled this plant to keep busy



THE claim that tipples designed and built by Link-Belt, attain high efficiency, can often be checked up by Link-Belt field men, as instanced by the following letter from a field representative:

"When I was in Salt Lake a short time ago, I had a talk with T. R. Stockett, General Manager, Spring Canyon Coal Company, for whom we built a tipple nearly four years ago. I asked him how business had been, and he replied they had worked steadily since September first and with considerable overtime.

"To my remark that this probably made up for some of the days lost during the summer, he said, 'We did not lose much time during the summer.'

"I said, 'You must have an excellent Sales Department.' He said they had, and that this combined with the excellent preparation of their coal, and the very general satisfaction it was giving to the trade, was the answer; and that this could be largely attributed to their splendid tipple and preparation plant.

"He summed it up by saying, 'If I had to rebuild our tipple and preparation plant, I do not know a thing to be changed'."

If you have a problem of handling or preparing coal, underground or on top, let experienced Link-Belt Engineers help you.

Our nearest office will be glad to send you Book No. 555.

LINK-BELT COMPANY

Leading Manufacturers of Elevating, Conveying, and Power Transmission Machinery and Chains

3680

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Pittsburgh - - - - - - 335 Fifth Ave.
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Kansas City - - - 1002 Baltimore Ave.
Seattle - - - - - 820 First Ave., S.

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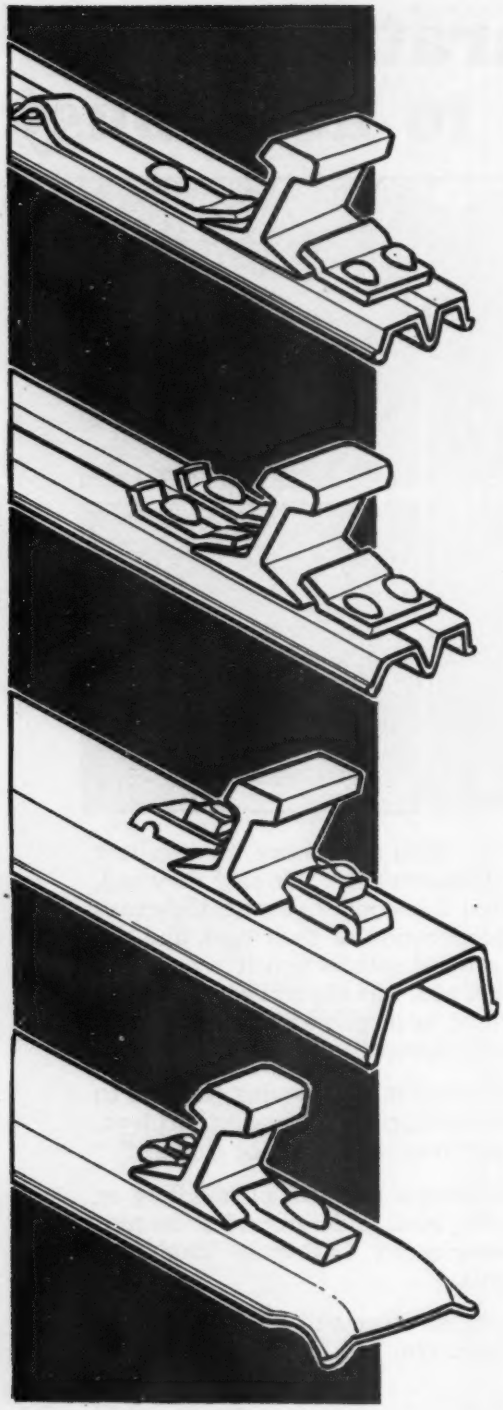
LINK-BELT



A Copper Steel Tie
for Every Purpose

M19A TIE is designed for room work. It is only 11/16" deep, and shallow depth is an item of importance in low seems of coal. Its width of 4¼" provides a substantial bearing surface. A workman can easily carry a bundle of six as M19A weighs only 2½ pounds per foot. The illustration shows No. 26 rail clip inside and No. 26 AA outside. Arrangement and type of clips are optional.

M26A is our most popular general purpose tie and is of the same design as M19A, but larger and heavier. 13/16" deep, 4¾" wide, 3¼ pounds per foot. Double clips No. 26K are shown with this tie. However, either M19A or M26A are supplied with single or double locking clips as preferred.

M20 TIE is designed for more permanent track in main entries. M20 is 2" deep, 6" wide, and weighs 6 pounds per foot. This same type is available in two other weights: M18—1½" deep, 5" wide, 4.2 pounds per foot, and M27, described below. No. 23 rail clips, inside and out, are illustrated. These clips are separate from the tie. Locking clips, riveted on, can be furnished.

M27 TIE is for heavy duty service. 2¼" deep, 7" wide and weighing 9 pounds per foot, this tie will accommodate rails up to 85 pounds per yard. The recent trend toward heavier equipment has made M27 widely popular. Ends may be crimped on any Carngie Ties if desired. No. 23 inside clip and No. 120 outside clip are illustrated.

All Carnegie Ties are made of Copper Steel, thus greatly retarding corrosion and insuring the maximum length of service. A copy of our Light Rail and Mine Tie Catalogue will be sent at your request.

CARNEGIE STEEL COMPANY

Subsidiary of United States Steel Corporation

PITTSBURGH, PA.

30

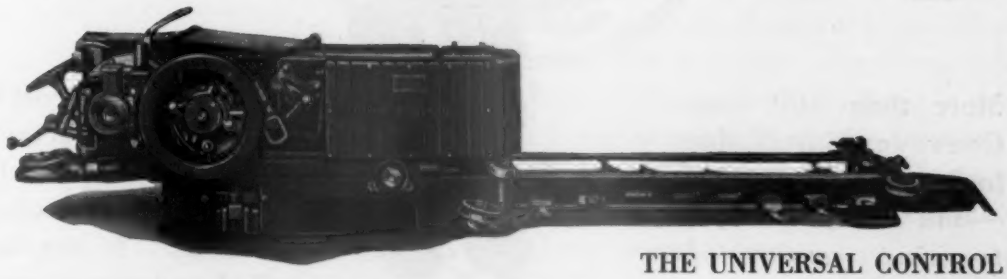
CARNEGIE
COPPER STEEL MINE TIES

Take their word—

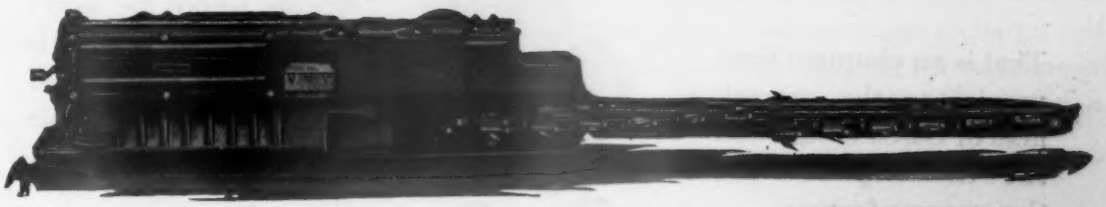
Your Electricians and Your Runners KNOW Cutting Machines!

There must be substantial reasons why these men—
men who have lived with coal cutting machines
daily for years—choose the

Goodman Shortwall Machines



THE UNIVERSAL CONTROL



THE LOW VEIN

A Man Will Do Better and Faster Work with a Machine He Likes.

—42 YEARS of Designing and Building Electric Coal Cutters—
That's the Experience Behind the Goodman Shortwall
of Today—Experience that Speaks for Itself!

There's a Goodman Branch Sales and Supply House Near You.

(7)
GOODMAN MANUFACTURING COMPANY
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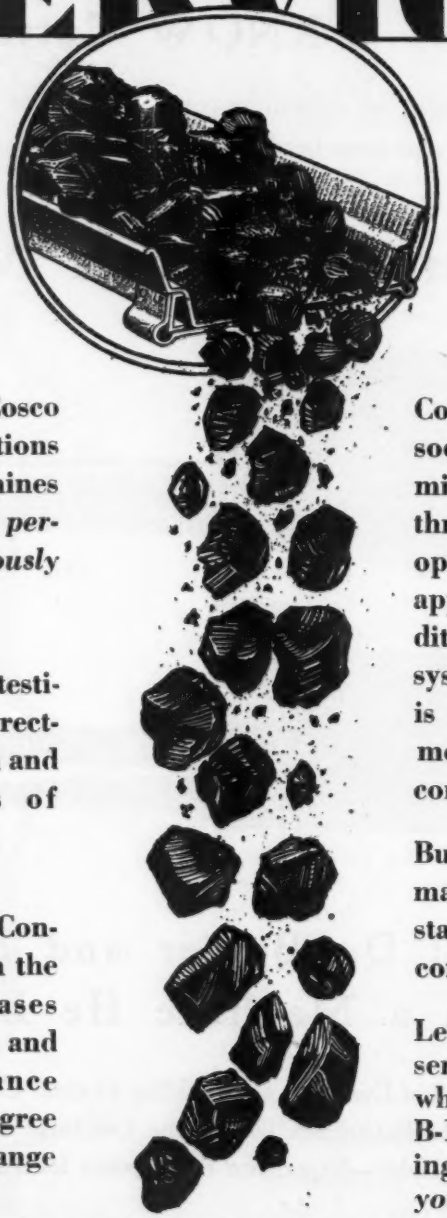
Locomotives - Loaders - Coal Cutters

PITTSBURGH—HUNTINGTON, W.VA.—CINCINNATI—BIRMINGHAM—ST. LOUIS—DENVER—PRICE, UTAH

CONTINUOUS SERVICE

COSCO



Shaker CONVEYOR

More than 400 Cosco Conveyor installations in American coal mines —*and every one performing continuously and successfully.*

That is an eloquent testimonial to the correctness of Cosco design and the thoroughness of Cosco manufacture.

The Cosco Shaker Conveyor equipped with the "Duckbill" increases output per man and lowers maintenance costs to such a degree that losses easily change to profits.

Cosco's small first cost is soon saved by economies it makes possible throughout your mining operations. It can be applied under roof conditions where no other system can be used. It is the most elastic and most readily movable conveyor system known.

Built from American materials to American standards for American conditions.

Let our engineers present facts and figures on what the Cosco A-20 or B-15 Drives and Troughing can accomplish in *your* mines.

CONVEYOR SALES CO., INC.

299 Broadway, New York

DISTRICT SALES OFFICES

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Scranton, Pa., *Mears Building.*
Huntington, W. Va., 1223 *Tenth Avenue.*
Knoxville, Tenn., 2725 *Magnolia Avenue.*
Salt Lake City, Utah, *Salt Lake Hardware Co.*
Denver, Colo., *Stearns Roger Mfg. Co.*
Birmingham, Ala., 1802 *American Trust Bldg.*
Chicago, Ill., 224 *So. Michigan Avenue.*
Pittsburg, Kansas.

"Convey Your Coal The Cosco Way"

Safeguarding Production at Keystone, West Virginia

WITH the recent delivery of three Baldwin-Westinghouse Permissible Type storage battery locomotives at the Keystone Mines, the Houston Collieries Company has placed in operation haulage equipment which meets the highest standards of safety.

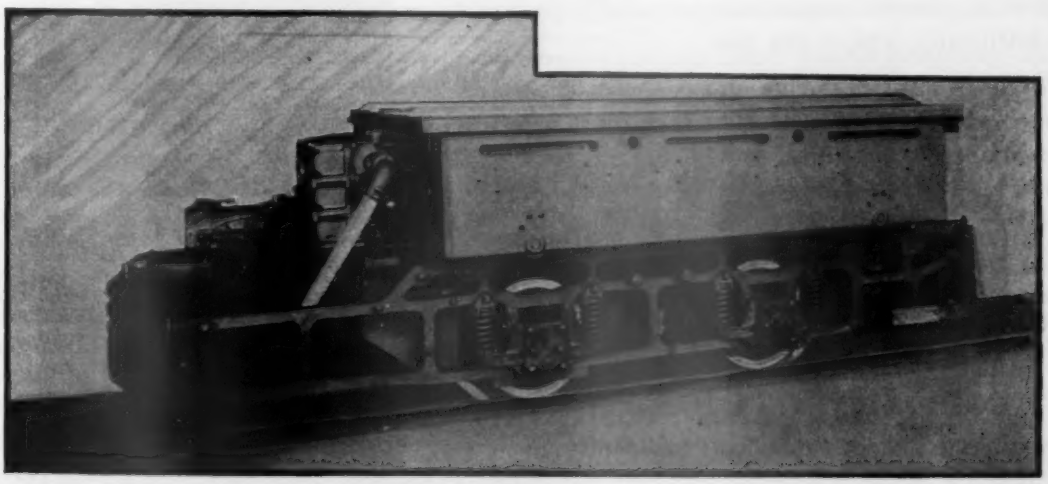
In these locomotives, which are approved by the United States Bureau of Mines, all equipment, such as motors, controllers, resistors, switches and meters, is enclosed in substantial explosion-tested cases. Another safeguard and a time-saving feature is the use of trip-free handle circuit-breakers in the main circuit instead of fuses.

Additional features include field control, assuring more work per battery charge, self-equalizing coil springs, and the well-known Baldwin-Westinghouse Barsteel construction.

One of the Baldwin-Westinghouse Permissible Type Storage Battery Locomotives placed in service recently in the Keystone Mines of the Houston Collieries Company.

THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA PENNSYLVANIA

WESTINGHOUSE ELECTRIC & MFG. COMPANY
EAST PITTSBURGH PENNSYLVANIA



Baldwin-Westinghouse

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Core Drill Your Coal and Metal Lands

Secure accurate, complete information about your coal or metal seams by utilizing precision tools perfected for those classes of prospecting through 50 years of development—

SULLIVAN DIAMOND DRILLS

Sullivan Diamond Drills remove continuous cores of rock, and coal, or ore. They show exactly the depth, thickness, and inclination of the seam, the presence of partings and their location in the vein.

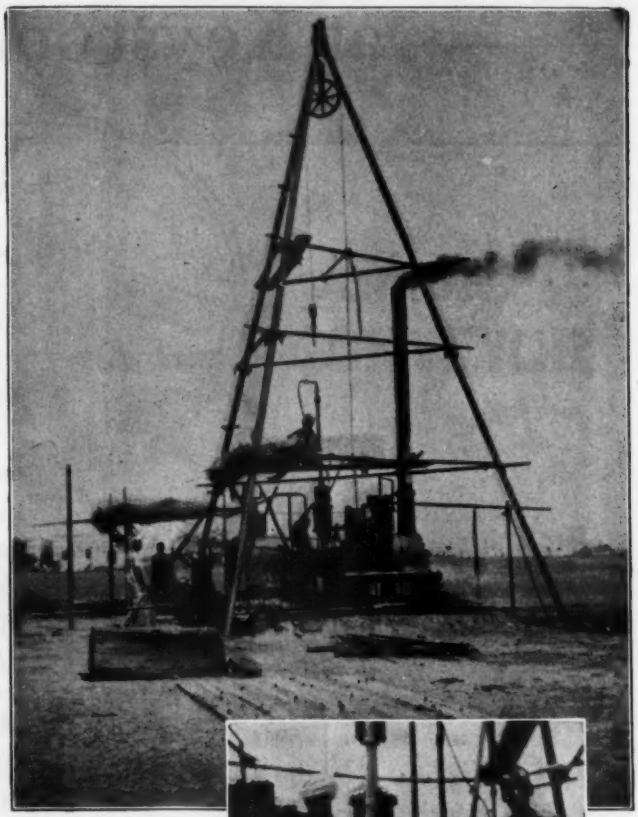
Special devices secure cores from even the most soft or friable coals.

Coring Contractors since 1884

The Sullivan Core Drill contracting department, established in 1884, will conduct your mineral land proving work under a simple agreement, rapidly, scientifically, and at low cost.

Many hundreds of satisfied clients, and some millions of feet of core drilling successfully completed, are your guarantees.

Send for the 80-page Sullivan Diamond Drill Catalog, and information about Drilling Contract agreements.



In India, as in most other parts of the world where minerals are sought, Sullivan Diamond Drills have been used repeatedly for exploring coal and metal properties. The core removed is shown in the foreground of the upper picture.

Sullivan Products for Coal and Metal Mines

Sullivan Catalogs on Air Compressors, Mine-Car Compressors, Hammer Drills, Drill Sharpening Machines, Coal Cutters, Coal Loaders, Track Cutters, Cutter Bit Sharpeners, Portable Hoists, and Air Lift Pumps, will be gladly sent on request.

SULLIVAN MACHINERY COMPANY

808 WRIGLEY BLDG., CHICAGO, U. S. A.

SULLIVAN

Trade Mark

Boston, New York, Huntington, Pittsburgh, St. Louis, Knoxville, Birmingham, Terre Haute, Duluth, Denver, Muskogee, Spokane, El Paso, Salt Lake City

Have you a rock disposal problem?

"... efficient and convenient method of handling the rock is by electric motor larries." From an address, "Rock Disposal in the Anthracite Field," by J. Latimer Lee, delivered before the Cincinnati Coal Convention this year.

A 35-ton, one-man, electric Larry car built for the Pine Hill Coal Company for handling rock in anthracite mining.

There are many places where refuse handling is a serious problem. For such these efficient Larry Cars can be built in any size and for any class of work. The one-man Larry above hauls, dumps and handles throughout entirely from the cab. It is driven by a 2-75 H.P.—250-volt motor with series and parallel drum type control arranged for dynamic braking. The car is standard gaged with eight wheels. Auxiliaries including dumping doors, dumping aprons, equalized brakes and four sand boxes arranged to work in pairs are air-operated from controls located in the cab.

The equalized braking system also has an auxiliary hand brake arrangement.

The air-operated dumping aprons can be lifted close to the body of the Larry and when extended outward are 12 inches above the rails. The two dumping doors, operated by air in a cam self-closing device, can be locked either open or closed.

A motor-driven compressor with reservoir maintain a constant pressure to operate facilities.

Write for further information about this efficient means of refuse handling.

VULCAN IRON WORKS OF Wilkes-Barre, Pa. U.S.A.

DU PONT
REG. U.S. PAT. OFF.

Gelatin-

The United States Gypsum Company mines gypsum at Grand Rapids, Michigan, with 40% du Pont Special Gelatin

The Homestake Mining Company uses du Pont Gelatin in its mines at Lead, So. Dakota, for blasting ore and driving tunnels

The Jefferson Island Salt Mining Company blasts rock salt at Jefferson Island, Louisiana, with 35% du Pont Special Gelatin

the versatile explosive

GELATIN DYNAMITES possess more variety and greater versatility than any other type of commercial high explosive. They range from blasting gelatin, stronger even than pure nitroglycerin, to 20% gelatin, the weakest grade that it is practical to make at the present time.

Broadly speaking, the strongest gelatins are used in submarine blasting and in the bottom of the holes in extremely hard rock with unfavorable breaking conditions, as in tunneling. The 60%, 50% and 40% gelatins are also used in hard rock tunneling, especially the 60% grade, and from 60% to 35% in most metal mining operations.

The lower strength gelatins are extensively used in non-metallic mining, as in gypsum and rock salt and in mining some of the more easily broken ores.

The characteristics of the gelatins which make them particularly adapted for mining and tunneling are their high water-resistance, their plasticity, which enables them to stay put in the bore holes, especially uppers, and their comparative freedom from noxious fumes.

In all these characteristics, du Pont gelatins excel.

E. I. du Pont de Nemours & Company

Incorporated

Explosives Department *Wilmington, Delaware*

DU PONT

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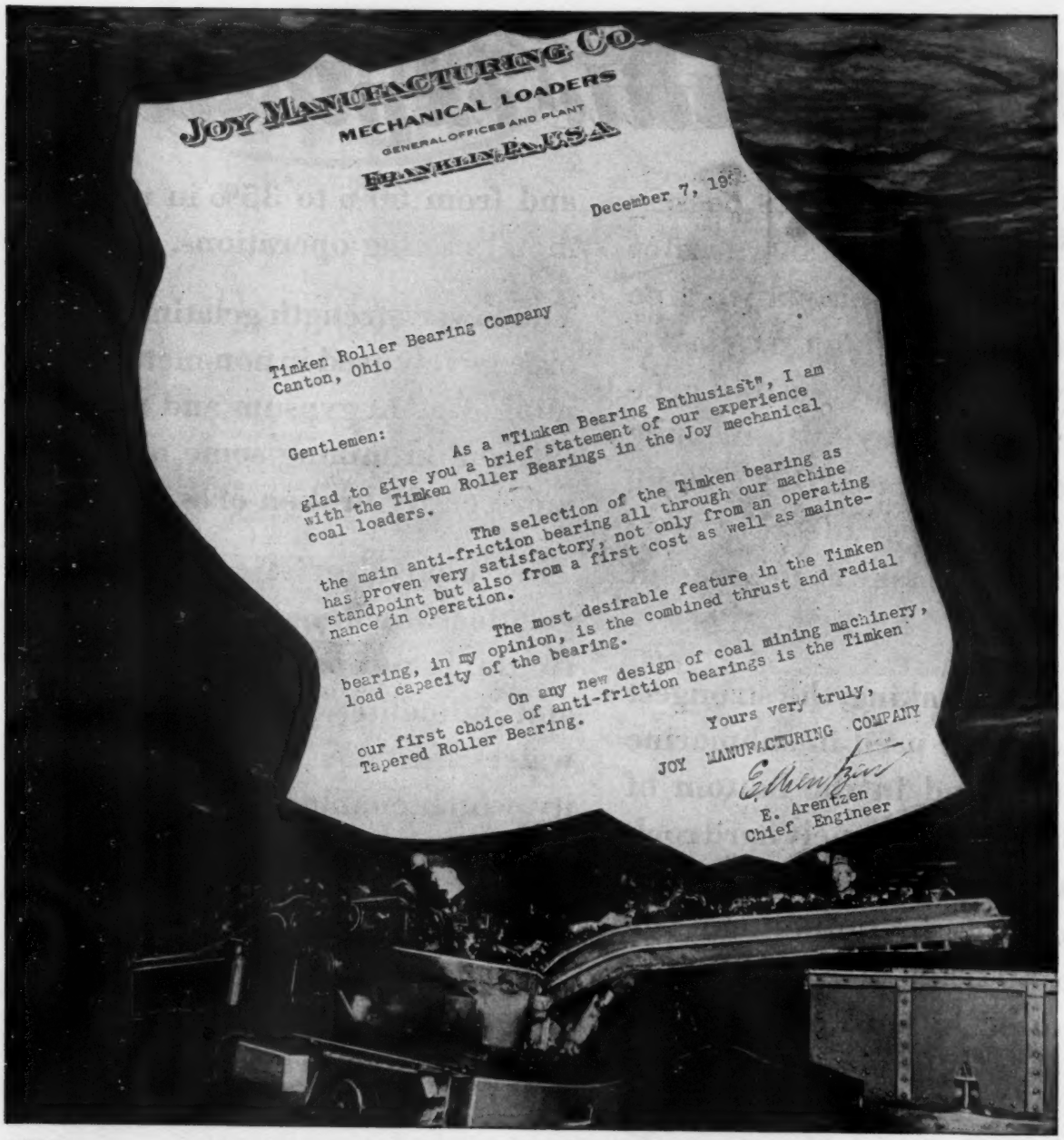
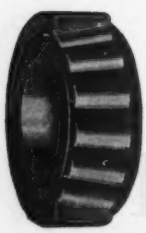
GELATIN DYNAMITE


JOY MANUFACTURING CO.
MECHANICAL LOADERS
GENERAL OFFICES AND PLANT
FRANKLIN, PA., U.S.A.
December 7, 19
Timken Roller Bearing Company
Canton, Ohio
Gentlemen:
As a "Timken Bearing Enthusiast", I am glad to give you a brief statement of our experience with the Timken Roller Bearings in the Joy mechanical coal loaders.
The selection of the Timken bearing as the main anti-friction bearing all through our machine has proven very satisfactory, not only from an operating standpoint but also from a first cost as well as maintenance in operation.
The most desirable feature in the Timken bearing, in my opinion, is the combined thrust and radial load capacity of the bearing.
On any new design of coal mining machinery, our first choice of anti-friction bearings is the Timken Tapered Roller Bearing.
Yours very truly,
JOY MANUFACTURING COMPANY
E. Arentzen
Chief Engineer

The first choice for JOY LOADERS



More than 15,000,000 tons were mined last year by Joy Loaders with Timken Bearings while working for 50 companies in 10 States. And in cutters, pumps, motors, conveyors and tipples, as well as in car journals and locomotive armatures, Timken Bearings were effecting almost unbelievable economies in power, lubricant and maintenance. The well authenticated records already established because of Timken rigidity and friction-elimination explain the increasing demand for Timken-equipped mining machinery. But, expect Timken results only from Timken Bearings — only in them are combined Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken electric steel.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

The
MINING CONGRESS JOURNAL
**A Monthly Magazine—The Spokesman For The Mining Industry—
Published By The American Mining Congress**

VOLUME 15 SEPTEMBER, 1929 No. 9

Editorials

Gold and the Federal Reserve Act

PERHAPS no one legislative act has been of greater benefit to the nation—and perhaps to the world—than the Federal Reserve Act. Through its great power it is able to prevent bank panics and to stabilize business conditions which, before its enactment, were subject to fluctuations of a disastrous nature.

Money is the life blood of trade. The Federal Reserve Bank is able to make money available to meet any limit of well-established credit. Gold is the basis of money and the beneficent influences of the Federal Reserve Bank rest upon a gold basis. It is an anomalous situation that the very act which rests upon gold for its stabilizing and fructifying power should at the same time work the greatest hardship to the gold mining industry. The Federal Reserve depends upon gold produced in the past and does not rely upon present production. Through its ability to supply an increasing amount of credit money, present production of gold has become less and less important. In a recent address the Governor of the Reserve Bank of South Africa urges upon the finance committee of the League of Nations an examination of the world problem of the purchase power of gold. He says:

"The question of attempting to prevent undue fluctuations in the purchasing power of gold is going to assume some importance in the near future. This is an international question which should be examined by the League of Nations; and the finance committee of the League has already begun collection of material on which to base a thorough-going inquiry into the whole matter.

"The law of demand and supply regulates the value of gold as it does that of any other commodity, and European economists are now dreading an advance in the value of gold. It would be a tremendous blow to nations which have stabilized their currencies in relation to gold to have price stability imperilled by an appreciation in the value of gold brought about by a demand out of proportion to the available supply.

"Central banks of Europe seem to be reverting to the idea that they must hold in their own safes the gold required for statutory reserves while the gold exchange standard is being gradually discarded. Central banks of Europe and America, therefore, have been endeavoring to come to some agreement to avoid unnecessary competition for gold.

"How does all this affect South Africa? As a gold producer, South Africa would naturally like to see an increasing demand for her products. If the nations used gold instead of notes for currency purposes, gold would be in great demand and would appreciate in value, and the gold producer would get more commodities in exchange for his gold. Thus South Africa's interests would seem to run exactly counter to those of Europe. South Africa's interests would appear to call for the full gold standard, under which each country kept its own supplies of gold and regulated its credit policy accordingly. It must be remembered, however, that under this arrangement world standards of value would vary according to accidental discoveries of gold and the unregulated demand for it.

"For this reason it is doubtful whether the world will ever again allow gold to be final regulator in currency matters as it was in pre-war days. Admitting the usefulness and perhaps the necessity of gold as the international currency, the whole credit policy and production of the nations should not be governed by the supply of gold. Is there not some way by which the available gold can be used economically and scientifically, so that it can continue to be used as the international currency, without exerting undue pressure on the economic situation?

"If there is likely to be a shortage of gold, South Africa's ultimate interests would be better served by preventing that shortage from having injurious effects —social and commercial—on Europe than by a mere policy of laisser faire. The latter policy might indeed mean some temporary profit to South Africa, but against this would have to be set the losses which would be certain to arise from reduced trade with Europe. In other words, you can't derive a permanent benefit from a policy which seriously injures the purchasing power of your best customers."

The gold producers of South Africa occupy a very similar position to that of the gold producers of the United States. For the general good they approve gold centralization although recognizing in it an almost overwhelming burden upon the gold mining industry. It is, however, unfair to say that "world standards of value would vary according to accidental discoveries of gold and the unregulated demand for it." The production of gold has been so uniform that no temporary increase or decrease could exercise any perceptible influence on world prices. The difference between any two years' production for the last 30 years is less than two-fifths of 1 percent of the world's monetary gold stock.

The great fluctuations in price levels have not been caused by changes in the world's monetary stock of gold but by the fluctuating amount of credit money made available for business transactions.

The President's Job

PRESIDENT HOOVER has inaugurated some interesting changes in meeting the public. It is quite plain that he does not propose to permit the public he is serving so ably to make his job impossible. For many years the crime of shaking the hand of the dear public has been practiced successfully throughout administration after administration. Ex-President Taft said that his record for one day at this job was something like 8,000 shakes! And other Presidents have had similar experience. But President Hoover seems to feel that such punishment is not a part of the duties of the President of the United States. So wholesale handshaking is being discarded. He has also established a rule which asks that those wishing to see him state fully their purpose in advance. And he will not permit his office to be the prey of the multitude of organizations who wish the distinction of entertaining a President, and having him address their members.

The *New York Times*, in an able editorial, points out that when Congress is in recess the President should have a fairly easy time of it, but instead that among his duties during this period have been: "Reducing the Navy, saving money on the Army, balancing the budget by cutting down expenses, putting the Post Office on a self-supporting basis, revising the tariff, appointing a few more commissions, selecting men for foreign service, planning for conservation of oil, starting the works at Boulder Dam, arranging for a survey of child labor and schools, repairing the Federal prisons and building new ones. . . . After easily clearing his desk of these matters, he gets off for a week-end fishing trip, mixed with important financial and political matters, with no one to bother him but the group already protesting that never before have we had a President so thoughtless or so wicked as to fish on Sunday."

The President's job is a strenuous one. Its duties are steadily increasing. Mr. Hoover can, and will, measure up to its requirements, but certainly the "dear public" should be made to understand just what the duties of this great office are, in order that a minimum of needless hardship may ensue.

The Spokane Meeting

A REAL "mining week" is being arranged for in the great Northwest. September 30 to October 5, the greatest mineral organizations of this district and of the country join hands in an effort to help the mining industry. The city of Spokane is the official host, and the whole Couer d'Alene welcomes The American Mining Congress, The American Institute of Mining and Metallurgical Engineers, The Northwest Mining Association, and the Canadian Institute of Mining and Metallurgical Engineers in their joint convention.

A program as broad as the industry itself has been arranged. Mining men throughout the western territory, and many from the East, will journey to Spokane to participate in the event. Among the subjects that will be discussed are: The Public Lands Question, with the proposal of Secretary Wilbur to return to the states the surface rights in the public lands, as the basis of discussion; The need for cooperation between the mining school and the metal mine operator; Mineral taxation; The great resources of the Northwest both as to nonmetallics and coal; Practical operating problems of the Couer d'Alene and the Butte districts; Geophysic prospecting, and many other interesting subjects.

The opportunity offered is an exceptional one, and will be taken advantage of by many. Mr. Frank M. Smith, of the Bunker Hill and Sullivan Mining & Con. Co., who occupies an unusual position in relation to the meetings, in that he is chairman of each of the participating organizations, is in charge of the program. The announcement elsewhere in this issue proves conclusively that the mining man is a versatile fellow, and that worthwhile things are being done through cooperative effort. "Mining Week in the Northwest" will be a great event.

Another Tariff Bill

IRRITATION over proposed changes in the tariff offered by the Senate Finance Committee has developed in political circles to such an extent that it is extremely doubtful whether the Senate will be quick to act when the bill is reported September 4. The political angles to be ironed out are numerous, as are also the industrial angles. The tentative bill of the Senate Finance Committee carries many reductions in the rates proposed by the House bill, and also in many instances reduces the rates below those provided by the present tariff law.

Some of the reductions proposed appear to have been decided upon because of party or group differences of opinion as to tariff policy; others appear to have come about because of the fact that no witnesses appeared at either House or Senate hearings in connection with the items affected. In the latter case the natural presumption would be that the present rates on these items are satisfactory. Apparently the Finance Committee chose to regard certain of such items as proper items upon which to make reductions. Whatever were the reasons which actuated the committee in proposing reductions below present rates, the industries affected will be heard from in no uncertain manner before any tariff bill is passed.

The fact that a protected industry is prospering under present rates furnishes no excuse or justification for lowering those rates. And if the record of imports shows that imported materials or commodities are going into markets that can be fully supplied from domestic resources at reasonable prices, then there exists a most potent argument for increases in the tariff rates on such materials or commodities in order that domestic industries may have the full benefit of their natural home markets and domestic labor may have the fullest employment at fair wages. Where our domestic resources are adequate to supply all the needs of this country, domestic competition is keen enough to insure fair prices and no foreign competition is desirable.

The tariff bill proposed by the Finance Committee is so different from the House bill, so different from the kind of a bill the agriculturists seem to want, and so different from what most of the industrialists believe they require, that a general rumpus over the measure is in prospect. The convictions of many Senators on the general makeup of the proposed legislation are so uncompromisingly fixed that there appears now to be no possibility of them being whipped into line so that a tariff bill such as is now proposed can be passed at this special session. If this proves true a new bill will have to be written on the Senate floor.

State Police Power

THE chairman of the Law Enforcement Committee, Mr. George Wickersham, appointed by President Hoover, has called attention to responsibility as between the Federal Government and the several states in the matter of enforcement of the law. His statement has a far-reaching significance. It has been criticized and endorsed by both drys and wets. It embodies the central thought which controlled the makers of the Constitution, and is based upon a principle, without which, that constitution could never have received the approval of the 13 original states.

And it applies with force in many other fields than that of prohibition to which it refers. In the early history of the United States this principle was applied to the control and disposition of the public lands. The homestead and mining laws offered to the pioneer the reward of ownership in consideration for the sacrifice which he must make in order to build into populated commonwealths the wide wastes then known as the great American desert.

In the early days of the West, before there were even territorial governments, violations of the law were so frequent as to menace the safety of the communities. This situation obtained to some extent even after these governments had been organized, because of the distance from the sources of authority. To meet the situation, vigilantes were organized, who by the exercise of summary punishment brought order out of chaos. As soon as possible legal courts were organized under the direction of the immediate community. As soon as the territorial communities were in position to guarantee the maintenance of government, states were formed and those states were charged with the responsibility of local government. The police power of the state was the only source of authority in the protection of the public welfare and the safety of the individual. The Federal Government was thus relieved of all responsibility except as to certain cases between the separate states and between citizens of different states. The system was complete so long as the police power was entirely a part of the state's responsibility.

Local self-government has always been recognized as the key to law enforcement.

Power To Tax and Control

IT IS very significant that Mr. Wickersham, as head of the Law Enforcement Committee, should make this statement, and that almost simultaneously a member of the President's Cabinet should make a similar announcement with reference to the public lands of the West.

For many years the public lands passed rapidly into private ownership and became subject to the state's taxing power. Disputes between rival claimants for public lands were tried by the local land office, first, with final appeal to the Interior Department. In these contests the Government's only function was to decide as to which of the rival claimants had best claim to title under the general land laws. Under these conditions the West prospered. But its further development was checked by a new theory of conservation which found its culmination in the leasing law providing that titles should remain in the Federal Government and that rental value upon a royalty basis should be paid to the Federal Government. This led to conflict and dissatisfaction. It left the representative of the Government both trial judge and a party in interest. If application for patent was denied the property immediately reverted to the Government which the trial judge represented. It left the western states under obligation to support permanently a republican form of Government and to enforce law and order over a large area over which it had no control and which it could not tax. Mr. Wickersham may not have had in mind this peculiar situation in his announcement with respect to a conflict between Federal and state authority but what he said applies with particular force to the responsibility which each of the several states should be permitted to exercise in the control and development of that wealth within its borders which, if the state is ever to assume its proper place, it must have the power to tax and control.

Mining Title Controversies

THE General Land Office is frequently called upon to determine disputes as to titles between mineral claimants and the various agricultural titles which are provided by the Federal land laws. The mining code requires that locations shall be filed in the office of the county clerk and recorder of the county in which the claim is situated. There is no requirement that this filing shall be recorded in the Federal land office in the district in which it is situated. A mining claimant may file his claim, pursue his assessment work in accordance with the legal requirements but until he applies for a patent thereon the district land office has no notice of the claim. The applicant for title under the agricultural or grazing laws files his claim with the district land office and proceeds to the last stages of patent without knowledge of the mining claim and without giving the mining claimant any notice of the agricultural entry. This situation calls for such change in procedure as will prevent this conflict. Either the agricultural claimant should be required to file notice of his claim in the county recorder's office or else the mineral claimant should be required to record his filing with the district land office. It is unjust that claimants shall be permitted to expend money in the perfection of a claim upon which a prior location had been filed. It would seem that the agricultural entryman should be required to file notice of his entry in the county recorder's office. The district land office records are not a legal notice of title. Its patents must be recorded in the county clerk's office to protect the title thereby granted. The record of the county clerk's office is the legal record of titles within the county and every entryman should be required to give notice of his claim in the manner required by law for the protection of other titles in the county in which the property is located.

Another reason: The prospector is rich in imagination and short in world goods. It is practically impossible for him to file claim in the district land office. His work is most important. The burdens on his effort should be reduced to the minimum. He works for the nation and the nation should protect him.

Mass Production

THE continually increasing efficiency of production in the United States is gradually extending the field of distribution of domestic production. Big business and mass production as it now exists would have horrified the most progressive of our people 25 years ago. To prevent the conditions which now exist, the Sherman anti-trust law was enacted 30 years ago. In that day the life of the country village with its shoemaker and its blacksmith was regarded as a necessity to the continued welfare of the nation as a whole. The public mind would have been in a panic could the present conditions have been foreseen. At that time and for many years previous it was believed that trade follows the flag and that the Government of the United States by maintaining its supremacy with foreign nations would be able to follow and protect its foreign enterprises and make them successful. In later years we have learned that efficiency is the keynote to foreign trade as well as a prime necessity in holding our own markets. The Congress of the United States is now engaged in considering a tariff measure looking to the protection of these home markets, not against foreign efficiency but against foreign cheap labor. Tariff restrictions in the past have made possible the control of practically 90 percent of our markets. The productive machinery necessary to meet this home demand enabled us to sell the other 10 percent of our national output in foreign countries. Just as the people of 30 years ago looked with consternation upon conditions which were depriving the local shoemaker of his right to exist as such, so today we look with trepidation at the competition of the chain store and the mail order house which are threatening the existence of the independent local merchant. Thus far in our history the stage driver has found employment with the railroad, the shoemaker and other small artisans have found employment with the larger manufacturing establishments and the enormous increase of production made possible through the wholesale use of machinery has added to the blessings of mankind and brought to the workman luxuries which were not possible to anyone in the older days.

"When Big Business Runs the Country"

ONE of our great metropolitan dailies published in its columns a letter from a reader which is not commented upon here because of its worth, but because it is surprising that such a paper would give space to anything so biased and founded upon so little fact. The correspondent says: "Government ceases to exist and gives no protection against poverty when big business runs the country. Prosperity today is the most barefaced lying propaganda except for 5 percent of Americans. The question is, when will people rise up and demand a decent living in this country from their Government."

As is pointed out in the preceding editorial, the day of the individualist is gone. We are living in an age of mass production. We have increased our population many millions; wages and industry have increased surprisingly in the last 10 years, and because of mass production the working man has as his every day necessities the things that a few years ago were unheard-of luxury.

According to the *Railway Age*, sleeping car travel has increased 25 percent since 1919, and day coach travel has declined 50 percent. They explain this situation in the "unparalleled prosperity that prevails in this country." And according to the United States Department of Commerce, "We are becoming a nation of professional men and women, with the numbers of toilers employed in the laborious duties once associated with manufacturing, definitely declining."

There are those who will rail at the world no matter what the condition. They are naturally pessimists. Being lazy and ineffectual themselves, they would reduce everyone else to their standard. Failing in arriving at comfort they demand a living from the "government" —which is, of course, from their fellow-workers, because the Government is not a separate entity. Government is but ourselves and should not be empowered to do anything that the individual can do for himself, and when it takes on burdens that mean unreasonable taxation, whether it be to give employment doles to the indolent, or the fathering of some enterprise that is unwise but lucrative in jobs for the dissatisfied, it defeats the very thing the contributor is protesting to obtain.

Our Economic Lives

SENATOR KING, the very able and estimable representative in Congress from the great mining state of Utah, should know better than is indicated in a recent statement on the "control of our economic life by trusts." The Senator decries the fact that the "great productive resources of the country are in the hands of a few monopolistic organizations," and insists that there must be "either a restoration of the competitive situation or drastic regulation by the Government of substantially all forms of interstate commerce."

Has the Senator forgotten the trust-busting days of Roosevelt? Does he overlook the Sherman Anti-Trust Law? Has he underestimated the rapidly growing tendency toward employe-owned industry? The mass production he is objecting to has certainly advanced this country far beyond any other nation, particularly as to standards of wages and employment. Were we to go back to the day of the competitive individualist, would it be possible to pay our present day wages? Would the individual be any better off than he was 20 years ago? And would the laborer have anything like the opportunity to become a wealthy man that he has today?

Our great productive industries are not in the hands of the monopolistic few. They are in the hands of the many. General Electric, General Motors, United States Steel, Standard Oil, many of the largest of the mineral producers—to mention a limited few—all have given their employes preferment in the matter of owning stocks, and each and all are under the "regulation" the Senator believes so desirable. Never in our history has competition been so keen, never before has labor been in such a sunny place, and never before have we as a nation been more prosperous. The *Wall Street Journal* points out that:

"Ideal execution of an ideal 'anti-trust' law would prevent any corporation from becoming any larger than any other in the same line of business. Americans do not need to be told that such a state of affairs, if attainable, would mean national economic suicide, or that the social control of industrial centralization is not a simple matter."

SOME TRENDS In Industry

Competitive industry today is not a social or charitable affair, and leadership is essential to success — Men most important factors in conduct of any business— The foreman and his relation to successful enterprise

By ALFRED KAUFFMANN *

"ADVANCING waves of other people's progress sweep over the unchanging man and wash him out." That statement, made by Mr. Kettering of the General Motors Corp. several years ago, is as true today as it was 35 years ago when as a boy I entered the shops of the General Electric Company at Schnectady, N. Y.

During those 35 years, four were spent in machine shops as an apprentice, three years as a student in engineering, and 28 years with the Link-Belt Company. With that as a background, I hope with some degree of interest to tell you about "Some Trends in Industry."

But before we dwell on the present-day situation, let's project ourselves back to the work day of 1894 and thereabouts, when we passed through the check-in gate at 7 in the morning and out again at 6 in the evening, with one-half hour for lunch.

Those were the days when the workman bought his own wooden wash pail, soap and towel, which he kept under his bench, and hauled out a few minutes before quitting time providing the foreman or Super. wasn't looking. If luck was with you, you got home by 7; if you missed your car, no telling when you reached home. There were compensations, however; if you were tired and needed a little nap, all you did was to set your planer, shaper or lathe to cut the air, and your buddy tipped you off when the boss's feet were heard. No piece work, bonus or premium. Some contract work in rare cases, but mostly a flat day rate, and not so very much at that. Quantity and high quality of employe production, at lowest possible unit cost, meant nothing to the average employe then. He knew little of the customer's side of the picture—seldom shared in any of the gains, consequently was interested only in putting in a day's work.

Of course, some of us boys made a little money on the side which helped swell our weekly pay. We carried lunches and beer to the men. A long pole in each hand held about 20 pails, so you can figure yourself what we made.

And in those early years we had every so often our nice little strikes because one or the other of us didn't want to do this or that, and as we all sympathized with each other, we quit, sulked, lost our pay, and finally came back, all because the fellow that hired us thought he was boss and we thought we were boss—when all the time neither of us was boss—but we hadn't learned yet that "the buying public is the boss of us all."

No matter what position we hold, workman, foreman, superintendent, manager, president, or what not, let us fail to give or to make good products, then see how quickly we'll be called to account for our work by the buying public.

Of course, the waves of progress taught us that millions were wasted in unnecessary strikes—we also learned that many losses were due to neglect on the part of the manufacturers to give the same consideration and attention to the human element of their factory as they gave to their machinery. The employes learned also that the employer was their agent who found purchasers for the product of their labor. So between the two we learned that many years of labor were needed in order for a worker to recover his wasted savings, or for the manufacturer to replenish his loss.

"INDUSTRY, instead of belonging to the privileged few, is passing into the hands of the many. Today there is an army of employe-owners in every large organization. The passing of a dividend becomes a serious matter if the action hits the pocketbooks of the workmen, foreman superintendent and company officers."

* President, Link-Belt Company, Chicago, Ill. From an address before the National Association of Foremen.

Treat 'em rough, and tell 'em nothing, was not very far from the true relationship between management and employes in manufacturing plants in the early days.

The underlying point of view was that a firm hand, together with a withholding of all except the most meager information about the business, was necessary in successfully handling factory men.

Today, just exactly the opposite views are held by executives whose function is the handling of employes. Men today want to know what it's all about. They are intelligent enough to comprehend the facts, and to use them constructively, and it's good business to give them the information.

Old customers are the backbone of any business. If we keep them satisfied with price and quality and delivery we will have less customer turnover. When these facts are brought home to employes, it will stimulate them to appreciate that their performance has a direct bearing upon the marketability of the product. Losses and wastes invariably are reduced by the arousal of interest. So I say again, consider the factory employes as part of the sales force, and tell them everything.

It hasn't been so long since we wiped out the white-collar complex—the false barriers between office and factory employes, which used to worry many executives. What was more galling than to have an office man walk through the shop and look down on the man in overalls?

And when it came to sports, like baseball, golf, or any other games, can you picture a white-collar man and an overall man from the same company playing on the same nine, or in the same foursome? But time has brought a democracy in manufacturing organizations which has changed all this.

It wasn't an overnight job. It has been a long time developing. It has grown so slowly that some of us little appreciate both its present extent and its possibilities for good in modern management.

So during all these years in which the waves of progress have swept on, and made a distinct evolution in industry and industrial management, the unchanging man has always been washed out of the picture.

Modern business is organized in such large units today that in an ever-increasing number of cases, men who 25 or 30 years ago would have been in business for themselves, are today important factors in large corporations. Men with high qualifications devote their talents to marketing, production, accounting, or some other phase of the company's business, but irrespective of its many ramifications, the fundamental principles underlying business success are few in number and simple in character. To start with, the object of being in business is to make profits, and the index of success is the ratio of the profits actually earned, to the real profit-making possibilities of the business.

> "EVERY man pays for the amount of bossing he requires, and likewise every man's wages increase in proportion to his ability to act as a boss of foreman of himself and others. The lower the wage rate, the greater the amount of watching and direction required. The highest wages are paid to men through whose ability the largest number of other men may be profitably employed."

Having determined what these profit-making possibilities are, the next step is to ascertain what the causes are which contribute to failure to realize these potential profits.

We must find out to what extent this failure is due to manufacturing inefficiencies—to excessive sales costs—to short-sighted or incorrect company policies—to defective accounting methods—to ineffective or inadequate advertising, or to still other conditions.

> "... AN industrial plant is only a mass of junk unless someone is around to see that the machinery becomes tools of production. And that takes Human Beings. . . . Men are not such certain quantities as money, materials and machinery. A machine will do a known quantity of work in a known time. A man will do such work as he is willing and capable of doing."

Bear this in mind—mergers of small companies into one large company provide no substitute for competent management. After they are set up and operating as a unit, their earnings, as in any other form of business, depend entirely on the sound judgment and foresight of the management.

But with big business and mergers, an entirely new condition was created. Industry instead of belonging to the privileged few, is passing into the hands of the many. Today there is an army of employe-owners in every large organization. Does not this put an added responsibility on the management? The passing of a dividend becomes a serious matter, if the action hits the pocketbooks of the workmen, foreman, superintendent and company officers. Also workers who are now part owners of their companies are beginning to have a better understanding of the duties and difficulties of management.

Now what part do we play in this picture? Most of us in this room are interested in the manufacturing end. What proportion of the failure to get the best out of our plants can be pinned on us? We all know that an industrial plant is only a mass of junk unless someone is around to see that the bricks, mortar and machinery become tools of production. And that takes Human Beings.

There may be all kinds of trends in industry, mergers, consolidations, and what is sometimes called "Vertical Trusts"; or history may bring about the cutting up of the big units into small ones again, but what will always be needed will be men to do things. Men are not such certain quantities as money, materials and machinery. A machine will do a known quantity of work in a known time. A man will do such work as he is willing and capable of doing.

Men, then, are the most important factors in the conduct of any business. And what difference does it make whether we mention this before a gathering of foremen, salesmen or executives, when the cry is always the same. Forget the title

> "THE object of being in business is to make profits, and the index of success is the ratio of the profits actually earned to the real profit-making possibilities of the business."

tacked onto our names, and look at it from the big opportunity standpoint. Men grow by having responsibility laid upon them. You may be a foreman today, and a superintendent or manager tomorrow. The same applies to the workman under you. In a sense you are his manager. Encourage him, let him know that he has a chance to get ahead, and that his chance lies in himself, and you will get further than any scheme of profit sharing, bonus, or welfare work, though they all may be very helpful.

The chance to say "Yes" to the question "Am I getting on" is what appeals to most men.

You men here who are foremen—

Are you not the business managers of your department? Would you or could you do differently than you are now doing, if you were able to put your department in a separate building, on a different lot, and put a sign with your name over the door?

You were not picked because you had a pull. As business manager of your department you were chosen because you had certain definite qualifications. You were a good workman, a master craftsman. You understood the "know-how" of the business, and you know how to get along with people.

You know better than I do the many petty things that come up during the day or week, the burden of which must be borne by you. You know the most important factor is maintaining high quality and low cost. Why tell you anything about the direct loss due to spoiled work, or that rush jobs are always more expensive than regular jobs?

You need new men in your shop. Either you, the foreman, or the employment man must hire them. Both of you are poor salesmen if you can't sell the job to the prospect, because, remember the man who asks for employment is a buyer of a job, and if you need him it is your business to sell him one.

Some of you may, but all of you should, know more about the practical knowledge of manufacturing economies and accounting—have a clear insight into such overhead items as equipment depreciations—tool cost—scrap charges—supply costs—supervision and inspection charges and the like—in their relation to direct charges and total costs.

But more important than all is a working knowledge of *human beings*.

Bear this in mind: Every man pays for the amount of bossing he requires, and likewise every man's wages increase in proportion to his ability to act as a boss or foreman of himself and others. The lower the wage rate, the greater the amount of watching and direction constantly required. The highest wages are paid to the man through whose ability the largest number of other men may be profitably employed.

I want to say this in conclusion:

Competitive industry today isn't a social or charitable affair—it is a conflict, and leadership is required to bring success.

It takes "guts" to stay in the game.

Some of us who handle men succeed only in proportion as we intelligently direct the work; that is, as we get intelligent work from the men who work with us.

So I repeat what I said at the beginning—the opportunity is here—if we don't take advantage of it, then the advancing waves of other people's progress will sweep over us and wash us out.

SHIPBUILDING PROGRAMS FORECAST LARGE CONSUMPTION OF COPPER

Prospective building programs of the world's merchant marine and navies indicate the construction of 3,000,000 gross tons of shipping per year, according to a survey of the marine field just completed by the Copper & Brass Research Association. The survey points out that at the beginning of the present year merchant shipping under construction in all countries totalled 2,607,000 tons, of which 1,212,000 tons were steamships and 1,395,000 tons were motor ships. Great Britain had 705,000 tons of steamships and 536,000 tons of motor ships under construction, Germany 226,000 tons of steam and 157,000 tons motor, and the United States 37,000 tons steam and 5,000 tons motor.

In naval construction, unless some great advance is made in limitation of armament or there is abrogation of treaty schedule, the survey predicts that during 1929 to 1941 replacement of capital ships will probably reach 1,715,000 tons of which the United States and Great Britain will each build 525,000 tons. In addition to replacement, a practically equal amount of new tonnage will be built by the world's navies in the form of aircraft carriers, cruisers, destroyers, submarines and auxiliary vessels.

"The world tonnage of steam and motor vessels above 100 tons displacement," says the survey, "amounted to about 63,250,000 gross tons on December 31, 1928. The idle tonnage of the world amounted to 3,947,000 tons. It is considered that the majority of this idle shipping is of no further value. The yearly increase in world total tonnage should amount to about 1,000,000 tons.

"Considering the prospective building programs, which will amount to about 3,000,000 tons per year," says the survey, "the potential market for copper in this field could approximate 600,000,000 lbs. per year purely for use in new construction, if all possible equipment were made from this metal or its alloys. It is not assumed, of course, that this amount of consumption is in prospect at present. Repairs to the 60,000,000 or more tons of present ships will not require such an amount due to the enduring quality of the copper alloys, but in the constant modernization of these ships it is considered that 100,000,000 lbs. of copper is a small estimate of the amount used each year."

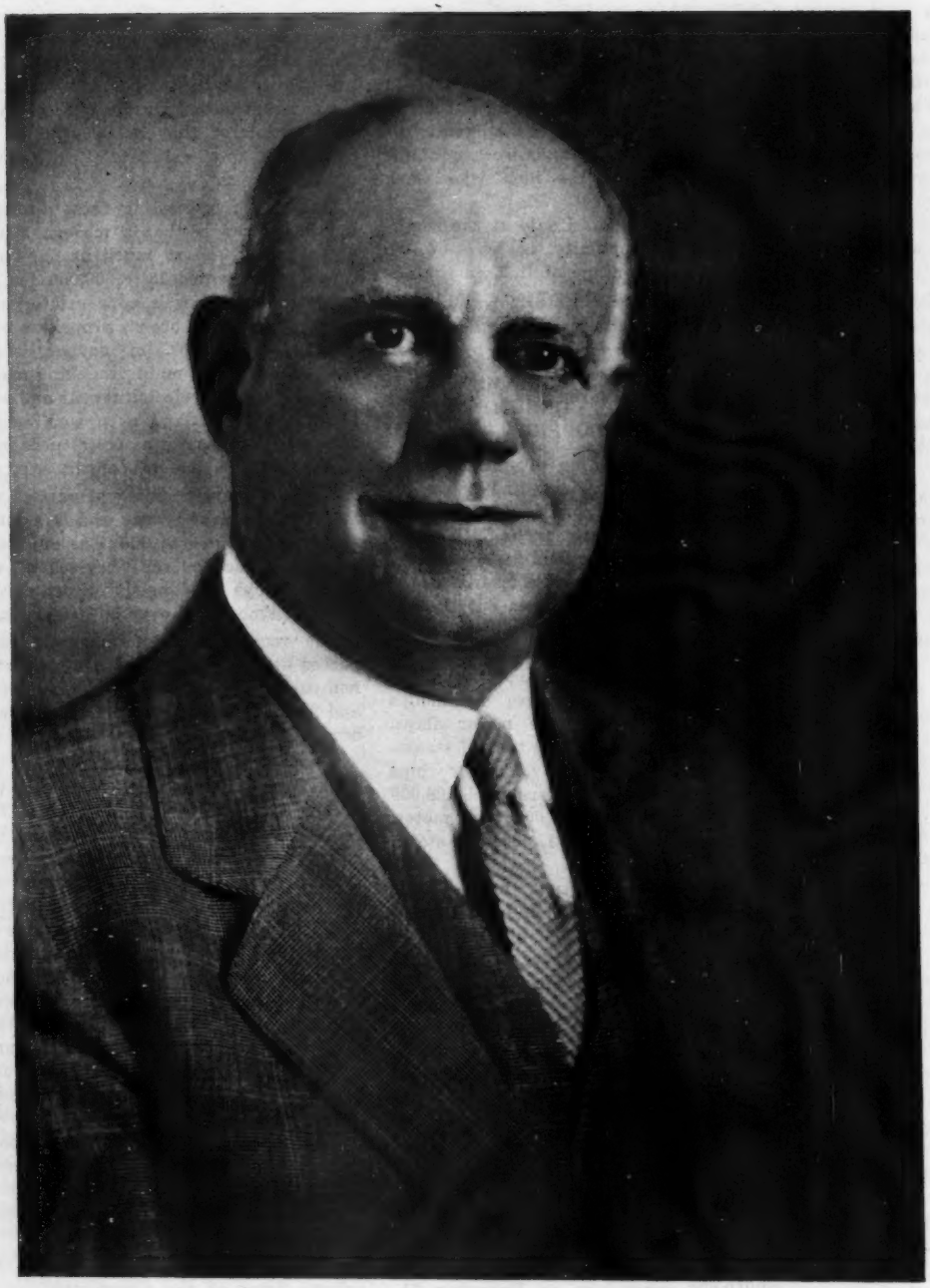
One of the interesting facts disclosed by the survey is that a modern 30,000 ton ship may be as much as one-tenth copper represented by 6,000,000 lbs. of copper installations if appropriate parts were copper. The bronze propellers may contain 53,500 lbs. of copper, shaft sleeves 53,000 lbs., main propelling machinery 200,000 lbs., electrical gear and wiring 3,000,000 lbs.,and even such inconspicuous installations as voice tubes may require 100,000 lbs. of copper.

Sea chests are an integral part of the hull. These are of bronze and in a large ship will weigh 300,000 lbs. or more. In a ship such as the "Leviathan" the copper alloys used in the direct driven turbines amount to over 5,000,000 lbs.

The requirements of magnetic compasses demand the use of non-magnetic, non-rusting metals. Non-magnetic and finishing plating in a large ship will account for 100,000 lbs. of copper.

"One of the largest demands for the metal in the marine field," continues the survey, "is for electrical purposes. The requirements vary, of course, from the ordinary demands of lighting and ventilation on a pre-war freighter, to the enormous demand on a post-war battleship. Probably the greatest demand is on an electrically propelled battleship such as the 'Tennessee'. This ship has enormous generators for transferring steam into electric power and enormous motors for transmitting this power to the propellers. Electricity furnishes power and lighting for ship's use, power for steering gear, anchor gear, ventilation, turret training and elevating motors, boat cranes, communication system, machine tools, galley equipment, ammunition hoists, fire control system and numerous other purposes.

"Due to the gradual absorption by private firms of the government operated lines in the United States." concludes the survey, "the shipbuilding interests of this country should show greatly increased industry. American owned shipping now handles about 30 to 35 percent of our own exports and imports and the desire of American steamship companies to secure a larger percentage of this trade will demand faster, more economical and larger ships to compete with those being built by foreign interests."



FRANK M. SMITH,
Chairman of the Board of Governors, Western Division, The American Mining Congress

Annual WESTERN DIVISION MEETING at Spokane

Western Division American Mining Congress offers unusual program for its annual meeting—Northwest Mining Association, American Institute of M. & M. E., and Spokane Chamber of Commerce cooperating—Trip through Couer d'Alene—Problems on every phase of operation to be discussed.

PRELIMINARY announcements concerning the annual meeting of the Western Division of The American Mining Congress, to be held at Spokane, Wash., September 30 to October 5, give promise of a most interesting convention. Mr. Frank M. Smith, Bunker Hill and Sullivan Mining Company, and chairman of the Division, is in charge of arrangements, in cooperation with the Mining Section of the Spokane Chamber of Commerce.

Cooperating with this meeting and in the program are the Columbia Section of the American Institute of Mining and Metallurgical Engineers, the Northwest Mining Association, the Spokane Chamber of Commerce, and the Canadian Institute of Mining and Metallurgical Engineers.

The convention will open on Monday morning, September 30, with headquarters at the Hotel Spokane, and under the auspices of the Northwest Mining Association. The topic for discussion at this session will be Development of Prospects and Financing of Mining Enterprises in the Northwest. A luncheon will be tendered delegates by the Northwest Mining Association, and B. H. Kizer, president of the Spokane Chamber of Commerce, will be the principal speaker. They will also be host at a smoker on Monday evening.

The Western Division will take charge on Tuesday morning, October 1, holding four major sessions devoted to the discussion of economic and practical operating problems. These sessions will be held at the Davenport Hotel.

Stanly A. Easton, vice president and manager, Bunker Hill and Sullivan Min-

Frederick W. Bradley, president, the American Institute of Mining and Metallurgical Engineers

ing & Concentration Company, will act as chairman of the opening session, and papers will be presented by a number of widely known mining men.

Robert E. Tally, president of The American Mining Congress, will present a paper on "The Mining Congress and the Metal Industry," which will present what the Mining Congress stands for in that industry. J. F. Callbreath, secretary, The American Mining Congress, will present a short review on Legislation for Metals, which will outline what has been accomplished in a legislative way, and what is on the calendar for mining. W. W. Bradley, State Mineralogist of California, will present a paper on "Developing the Non-Metallic Industries of the West." George Watkin Evans will discuss "The Coal Resources of the Northwest" in a most unusual way, his paper including much information that has never before been presented. Axel P. Ramstedt, Hercules Mining Company, will present a paper on "Mineral Taxation."

Harry L. Day, president of the Hercules Mining Company, will be the chairman of the second session when there are two important topics scheduled for discussion. "The Need for Cooperation Between the Mining School and the Metal Mine Operator" will be presented by Dean Milnor Roberts, College of Mines, University of Washington, and will be discussed by a number of prominent operators. The Public Lands question will probably occupy the greater part of the time of this session. A special program is now being arranged which will insure an unusually interesting discussion. Among the phases of this question to be discussed are "The Present Situation," "The West's Need in Relation to its Public Lands," and "The Wilbur Proposal."

The third session, on Wednesday, October 2, will be devoted to discussion of practical operating problems, H. G. Washburn, Federal Mining Company, acting as chairman. This session will confine its discussion to problems of the Coeur d'Alene, with papers on: "Mining Methods at the Hecla Mine (including Starr operation)," by Charles H. Foreman; "Milling Practice at the Morning Mill," by M. P. Dalton and G. S. Price; "Bunker Hill Underground Methods," by U. E. Brown; and "Mining and Milling at Grand View Mines," by R. W. Loyd, superintendent.

H. Foster Bain, secretary of the Amer. Inst. of Mng. and Met. Engrs.

On Wednesday afternoon the session will discuss operating problems in the Butte district, with William Daly, general manager of mines, Anaconda Copper Mining Company, acting as chairman. Three major papers will be presented: "Ventilation in the Butte District," by A. S. Richardson, ventilation engineer, Anaconda Copper Mining Company; "Development and Installation of the Hawkesworth Detachable Bit in Mining Operations in Butte District," by C. L. Berrian, general superintendent of mines, Anaconda Copper Mining Company; "Relation of Anaconda Copper Mining Company's Zinc Operations to Development of Complex Ores in Northwestern States," by R. B. Caples, general superintendent, Great Falls Reduction Department, Anaconda Copper Mining Company.

This will conclude the program directly under the auspices of the Western Division, the sessions on October 3 to be arranged by the Columbia Section of the American Institute of Mining and Metallurgical Engineers. According to advices from Dr. H. Foster Bain, secretary of the Institute, their program will include the following papers:

"Lead Refining Practice at the Bunker Hill Smelter," by A. F. Beasley; "Flotation Fundamentals," by A. M. Gaudin; "Legal Recognition of Geophysical Methods," by A. H. Rogers. There will also be a report of the Institute's Committee on this subject. There will be an "Experience Meeting on Results of Geophysical Prospecting with Reports from Rocky Mountain and Pacific Coast Institute Sections." It is also expected that a paper will be presented on results in the Sudbury Basin.

On Friday, October 4, the delegates will visit the Tainton Electrolytic Plant, and a paper will be presented by Wallace G. Woolf, which will deal with the operating details and difficulties of the plant. A dinner under the auspices of the Columbia Section of the A. I. M. E. will precede the presentation of this paper. This is the beginning of a two-day trip through the Coeur d'Alene, with visits at Kellogg and Wallace. On Saturday, October 5, delegates will visit the Hecla and Starr Mines.

Leon Starmont, secretary of the Northwest Mining Association

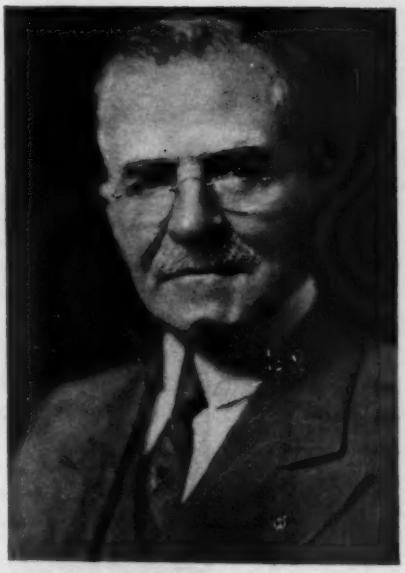
Frank M. Smith, who is in charge of the entire program for the week, is chairman of the Western Division, chairman of the Columbia Section of the A. I. M. E., president of the Northwest Mining Association, and chairman of the Mining Bureau of the Spokane Chamber of Commerce. He has arranged for a

splendid program of entertainment which will include: A luncheon on Monday, September 30, at the Hotel Spokane; a smoker on Monday evening, with some special entertainment for the ladies; an informal dinner on Wednesday, October 2, and the trip through the Coeur d'Alene.

It is expected that a number of eastern members of the Institute will attend, because of the general meeting of the Institute at San Francisco and the Engineers' trip to Japan.

The program is an excellent one; Spokane is a delightful city, and the trip through the mines of the Coeur d'Alene at this time of the year offer a combination difficult to surpass.

Robert E. Tally, president of The American Mining Congress



J. F. Callbreath, Secretary of The American Mining Congress

PROGRAM

Western Division Meeting

THE AMERICAN MINING CONGRESS

Spokane, Washington — **October 1-2, 1929**

TUESDAY, OCTOBER 1
(First Session)

CHAIRMAN: STANLY A. EASTON,
Vice President and General Manager, Bunker Hill & Sullivan Mining & Concentrating Company.

Papers:

The Mining Congress and the Metal Industry.
Robert E. Tally, *General Manager, United Verde Copper Company.*

Legislation for Metals—A Review.
Geo. H. Bailey, *Counsel, The American Mining Congress.*

Developing the Non-Metallic Industries of the West.
W. W. Bradley, *State Mineralogist of California.*

Mineral Taxation.
Axel P. Ramstedt, *Hercules Mining Company.*

The Coal Resources of the Northwest.
Geo. Watkin Evans, *Consulting Mining Engineer.*

TUESDAY, OCTOBER 1
(Second Session)

CHAIRMAN: HARRY L. DAY,
President, Hercules Mining Company.

Papers:

The Need for Cooperation Between Mining School and Metal Mine Operator.
Dean Milnor Roberts, *University of Washington.*
(This topic will be thrown open for general discussion.)

The Changing Federal Public Lands Policy.
Mark Woodruff, *Assistant Supervisor, Department of Conservation and Development, Spokane, Wash.*

The Progress Towards Western Parity.
Judge Charles E. Winter, *of Wyoming.*

The Dawn of a New Day.
J. F. Callbreath, *Secretary of The American Mining Congress.*

WEDNESDAY, OCTOBER 2
(Third Session)

CHAIRMAN: H. G. WASHBURN,
Federal Mining Company.

(This session will be devoted to practical operating problems of Coeur d'Alene.)

Papers:

Mining Methods at the Hecla Mine (including Starr operation).
Charles H. Foreman.

Milling Practice at the Morning Mill.
M. P. Dalton and G. S. Price.

Bunker Hill Underground Methods.
U. E. Brown.

Mining and Milling at Grand View Mines.
R. W. Loyd, *Superintendent.*

WEDNESDAY, OCTOBER 2
(Fourth Session)

CHAIRMAN: WILLIAM DALY,
General Manager of Mines, Anaconda Copper Mining Company.

(This session will discuss operating problems in the Butte District.)

Papers:

Ventilation in the Butte District.
A. S. Richardson, *Ventilation Engineer, Anaconda Copper Mining Company.*

Development and Installation of the Hawkesworth Detachable Bit in Mining Operations in Butte District.
C. L. Berrian, *General Superintendent of Mines, Anaconda Copper Mining Company.*

Relation of Anaconda Copper Mining Company's Zinc Operations to Development of Complex Ores in Northwestern States.
R. B. Caples, *General Superintendent, Great Falls Reduction Department, Anaconda Copper Mining Company.*

A MINING SCHOOL in a Great Mi

University of Utah campus. Fort Thomas in the background

LOCATED in the greatest non-ferrous mining and metallurgical center of the United States, if not of the world, the School of Mines of the University of Utah, at Salt Lake City, has long been recognized as one of the leading mining schools of this country, due to the fact that a large number of its graduates, not only in this country, but in the various mining districts of the world, hold positions of responsibility in the mining industry, as well as in allied industries.

The need for study and training in mining and metallurgy was recognized early in the educational development of Utah.

One of the first acts of the pioneers, after their arrival in the Great Salt Lake Valley, in 1847, was to establish schools. In 1850, only three years later, they founded the University of Utah, then called the University of Deseret. In 1851, however, it was discontinued, as it was thought advisable to direct all educational effort to the common schools, and instruction was not resumed until 1867. In 1884 the charter was amended and the legislature gave the University power to confer degrees. Seven years later engineering courses were established, and in 1901, mining was recognized as an integral part of the state's industrial development, and the State School of Mines was formally established by legislative action. Since that time such courses have been offered in mining and metallurgy as it was believed would best fit young men for mining engineers or metallurgists, as is done at all the mining schools of the country. At present a four-year course is offered in mining and metallurgy. Of necessity the first two years are quite rigidly prescribed. In fact there are few electives until the junior and senior years. Brief courses in business and economics are offered as a foundation for a more extended study by those who are particularly interested in these subjects. Students are encouraged to make good use of their favorable environment by working at the mines, mills and smelters during their vacations and while the University is in session opportunity is given to visit adjacent mines and plants for the purpose of studying some particular phase of mining or metallurgy.

Instruction in any line of engineering should deal more with the principles involved than with minute details of changing practice. In this regard the University is particularly fortunate in being able to show students the latest practice in mining and metallurgy by short trips, thus making it possible to confine instruction largely to the principles involved, and it is largely because of this fact that the School of Mines of the University of Utah is one of the well known mining schools of the country, due to its proximity to mining camps and smelters.

Advantageous Location

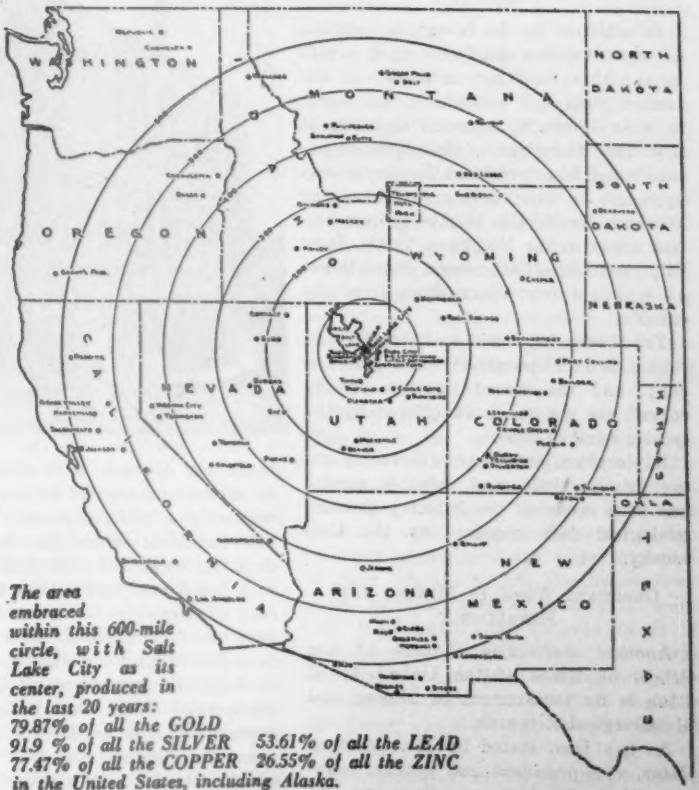
The University is situated about two miles east of the center of Salt Lake City on the western slope of the Wasatch Mountains. Due to its elevation of some 300 feet above the lower part of the city the view from the campus is unusual and very beautiful. Looking west across the city toward the Great Salt Lake, 20 miles away, one can identify the Garfield smelter and the two mills of the Utah Copper Company. To the southwest is the Murray smelter of the American Smelting and Refining Company. Still farther to the south can be seen the stacks of the United States Smelting, Refining and Mining Company at Midvale, about 12 miles distance. These plants can be reached by street car or interurban electric lines.

* Dean, School of Mines, University of Utah.

at Mining and Metallurgical Center

By R. B. KETCHUM *

LOCATED in the greatest nonferrous mining and metallurgical center, this school is distinguished for its Department of Mining and Metallurgical Research and its progressive ideas in engineering education—An Advisory Board consisting of heads of great mining enterprises a special feature—Cooperative work with Bureau of Mines.



The area embraced within this 600-mile circle, with Salt Lake City as its center, produced in the last 20 years:
79.87% of all the GOLD
91.9 % of all the SILVER 53.61% of all the LEAD
77.47% of all the COPPER 26.55% of all the ZINC
in the United States, including Alaska.

It also contains the greatest coal deposits of the country, some of the greatest oil and hydro-carbon deposits, great phosphate and iron deposits and many other important mineral resources.

Geographically considered, Salt Lake City is at the center of the mining industry of the western United States. Within the state and measured in an air line from the University a circle of 25 miles' radius will include, in addition to the above named plants, the Bingham district with the Utah Copper Mine, the Utah Apex, Utah Delaware, Ohio Copper, United States mines and other properties. The Park City district, to the east, is largely within this circle with its Silver King Coalition and United Park Utah Consolidated Mining properties.

A few miles to the south are the Little Cottonwood and Alta mining districts. Extend the radius of the circle to 50 miles and the International Smelting Company's mill and smelter at Tooele, the Ophir district and the blast furnace of the Columbia Steel Corporation near Provo, are included. A radius of 100 miles will extend the area to the Tintic district with its well known Chief Consolidated and Tintic Standard properties, the coal mines of Castle Gate, Kenilworth, Standardville, Spring Canyon, and others. Vernal in the heart of the great Uinta Basin region is about 126 miles away. The gold and potash producing district of Marysvale is 160 miles and the iron mines west of Cedar City are about 220 miles in an air line.

Within the state a circle of 600 miles radius with Salt Lake City as the center, will include practically all the important western mining regions. Within this area lie the greater part of the mines of Arizona, New Mexico, California, Montana, and Idaho, and the entire states of Nevada, Colorado and Wyoming. This area has within the last 20 years produced approximately 80 percent of all the gold, 92 percent of all the silver, 54 percent of all the lead, 77 percent of all the copper and 27 percent of all the zinc in the United States, including

Sunset on the Great Salt Lake

Alaska. These figures show the geographic relation of Salt Lake City to the western mining industry.

Geology

In addition to its favorable location, as regards mines and smelters, it is safe to say that no other university in the United States, or perhaps in the world, is more admirably situated to study at first hand the gigantic evolutions of nature which have produced the phenomena apparent on the earth's surface. The Wasatch Fault, the strikingly mineralized areas in the Bingham, Tintic, Park City, and Little Cottonwood districts are all within a few hours' drive from the campus.

The Rocky Mountain and Great Basin region are comparatively new geologically, and the record "written in the rocks" has not yet been effaced by the erosive hand of time.

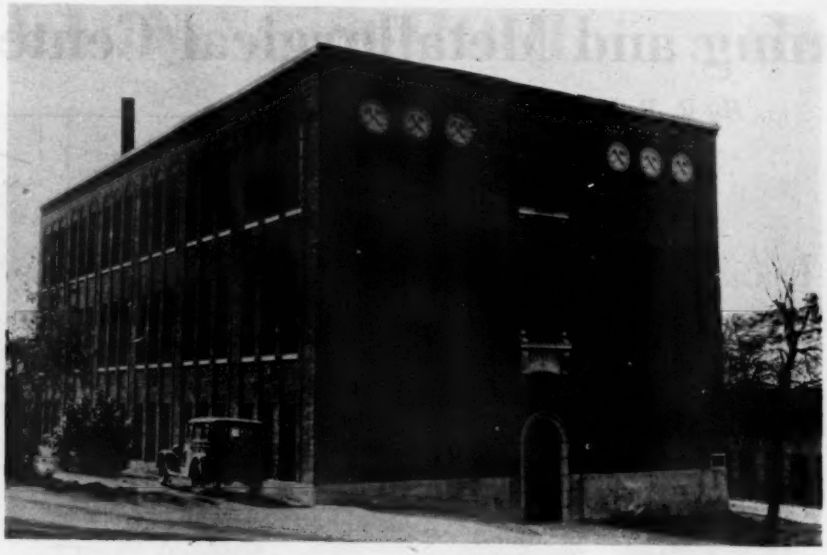
Exploration parties are constantly going into the field, and valuable service has been rendered the industry through geological data acquired by the University.

Graduate Work in Mining and Metallurgy

Another distinctive feature of the School of Mines of the University of Utah is its Department of Mining and Metallurgical Research.

As has been stated by Mr. Louis S. Cates, vice president and general manager of the Utah Copper Company and chairman of the advisory board to the University of Utah on its mining and metallurgical work, the solution, in the future, of the problems concerning the mining and metallurgical industry will depend upon industrial research, based upon fundamental research. In other words the industries, including mining and allied industries, which of course includes the metallurgical industry, must depend upon the scientists of our colleges and universities and upon the scientific bureaus of the Government, such as the Bureau of Mines, to furnish the fundamental data the industries need in devising new processes or for increasing the efficiency of existing ones. This is essentially true of the mining industry and particularly in metallurgy.

The Department of Mining and Metallurgical Research of the University of Utah was established because of this fact and has striven ever since its inception in 1913 to render that service to the mining industry which will permit of its becoming more efficient in its mining and metallurgical operations and broaden the scope of its usefulness. That such service is needed by mining and allied industries is due to the fact that as time goes on, the industry is called upon to treat the lower grade and complex ores. As to whether or not a mineral product is an ore depends upon whether it can be mined and treated at a profit. Consequently a mineral product, heretofore not considered an ore, may become so by devising ways and means of treating it at a lower cost and with a greater percent of recovery of its contents which may be of commercial value. If, therefore, the mining industry is to continue to hold the important position in the commercial world that it holds at the present time, it must have at its command the fundamental data it needs to enable it to devise new and efficient processes for the mining, milling, and subsequent treatment, metallurgical or otherwise, of those mineral deposits not being worked at the present time, due to their being too low grade or complex. Moreover, such data are needed by the industry in connection with the incessant demand made upon it for increasing efficiency in existing processes in order to meet the competition of similar industries in other countries, for as is well known, the mining and allied industries of this country can not hope to continue to be as important in the industrial work as they are today unless they are able to compete with similar industries in other lands. It is with these facts in mind that the Department of Mining and Metallurgical Research of the University of Utah has made its plans and is carrying on its work. In the first place, it realizes that in order to meet the future needs in this country of mining and allied industries for fundamental data, it will be necessary to train young men who have had the proper educational training as undergraduates—in the fundamentals of science, how to apply their knowledge as research men for obtaining the basic data needed by the industry in the solution of the problems which are now encountered or which may arise in mining or metallurgical work.



The new Mines Building at the University of Utah

The second object of the work of the department, in cooperation with the U. S. Bureau of Mines, is to obtain that fundamental data needed by the industry in connection with industrial research and for the solution of such problems as those above mentioned.

The department is fortunate in having an advisory board, consisting of the heads of the important mining companies of the territory. It also has the advice and assistance of technical sub-committees made up from the technical staffs of the same mining companies. Thus the problems of the industry are brought vividly to the attention of the investigators and invaluable advice and assistance are rendered. The work of the research staff of the fellowship men of the department has already been of considerable assistance in the mining and metallurgical industry and the majority of those who have held fellowships in the department in the past are now holding positions of distinction and responsibility in the industry.

The cooperative agreement between the department and the U. S. Bureau of Mines provides a happy combination for constructive work.

Thus young men who are interested in the pursuit of scientific research in mining and allied fields and who have the necessary scientific training will, it is believed, find it to be to their advantage to spend a year or more as members of the Department of Mining and Metallurgical Research either as graduate students or as fellowship men.

Co-operation With U. S. Bureau of Mines

The United States Bureau of Mines maintains a station at the University and its staff cooperates actively in the

work of the Metallurgical Research Department. Research fellowships are awarded annually to graduates of various colleges who carry on their researches while working for an advanced degree. Bulletins summarizing the work done are issued from time to time. Investigations have dealt with such problems as the volatilization of oxidized ores, the leaching of lead and zinc ores, the refining of hydro-carbons, the flotation of complex ores, the study of the fundamentals of flotation, the determination of the work of crushing, and other problems in the concentration of ores. Thus, the whole program of study is rounded into a schedule which utilizes to the fullest extent the advantages presented.

Buildings

The state has provided two buildings for the work in mining and metallurgy, and the second being a new one, erected last year. These buildings house the U. S. Bureau of Mines' Intermountain Station, the Mining and Metallurgical Research Department of the University, and the undergraduate department of mining and metallurgy. An appropriation from the last legislature will make it possible to use a third and smaller building as a pyro-metallurgical laboratory.

In order to carry out both the undergraduate and graduate work, sight has not been lost of the physical equipment necessary for instruction and for successful experimentation and research. To this end has been provided adequately equipped microscopic, flotation, gravity concentration, chemical, and pyro-metallurgical laboratories, a mill of pilot plant dimensions, and a completely equipped machine shop for the construction of such equipment and special apparatus as may be needed.

Library

In the new mines building, library quarters have been set aside, and the technical library of the University of Utah, a part of the main University library, has been moved into them.

The technical library is already recognized as one of the most complete in the Intermountain territory, and is constantly being added to from the income of the McGregor Fund, an endowment of $50,000.00 left to the University by James McGregor, a former Park City mining man.

It is planned to make this library available not only to students, fellows and staff members, but to the entire industry, the present accumulation to be considered a nucleus of a technical library second to none in the West.

ORE-DRESSING MICROSCOPY STUDIES BY BUREAU OF MINES

The study of complex ores has been the chief activity of the microscopic laboratory at the Intermountain Experiment Station of the Bureau of Mines, in cooperation with the University of Utah. This study has extended over a period of several years, and some of the most intimate mineral associations of lead-zinc-iron and copper ores have been examined.

The chief object of this work has been the prevention of waste through the application to mill operation of exact knowledge concerning the mineralogy of the complex ores and particularly the mode or complexity of association of the valuable constituents with each other and also with the gangue minerals.

In addition to the study of the ores, much work has been done on concentrates and tailings to supply important data to the mill operators concerning the mineralogical form in which losses were represented and, in many instances, making possible the application of corrective methods either by finer grinding or by making changes in the reagents used.

In the course of microscopically analyzing the mill products of a low-grade copper ore, approximately 200,000 individual sulphide mineral grains were examined, identified and classified, measured and their copper and iron content computed in terms of percentages. The graphs resulting from this study will show the distribution of the sulphide minerals in the various sieve sizes in the concentrates and tailings, and also the percentage distribution of iron and copper. The minus 200-mesh material was classified into four divisions, thus enabling data to be established on mineral grains in the three-micron size.

When completed, the graphs will enable the mill operation to be interpreted in terms of minerals lost and recovered as well as in percentages of copper. They will also show in what size range the best flotation results are obtained and the highest pyrite elimination accomplished.

BUREAU OF MINES MAKES REPORT ON OCHER AND OCHERY EARTHS

The mining and treatment of ocher, an earthy material used largely in the manufacture of paints, forms the subject of a study recently made by the United States Bureau of Mines.

Ocher or ochery earth is a natural mineral pigment composed largely of clay permeated with iron (hydrated ferric oxide). Its color ranges from yellow through orange to reddish brown, depending largely on the amount of iron present. Ocher grades into sienna, which differs from ocher in that it generally contains more ferric iron than it does clay, and in that when finely ground it is more used in stains than in paints. Good grades of ocher should contain 20 or more percent iron oxide, but the iron content of the material marketed varies widely. Ocher has a specific gravity of about 3.5.

There are two principal uses for ocher —in paints and as a filler for linoleum and oil cloth, states R. M. Santmyers, mineral specialist, Bureau of Mines, in a report just issued on the subject. Ocher is used to a limited extent as a pigment in coloring cement stuccos and mortars, for producing desired colors in earthenware when mixed with manganese oxide, and in very limited quantities for other minor uses. It does not seem to follow that the best ocher for pigment in paints is necessarily the most desirable as a filler in linoleum.

Ocher is produced more or less regularly in the following states named in order of importance: Georgia, Pennsylvania, Virginia, Alabama, California, Iowa and Vermont. Deposits have been found in other states, but are not known to have maintained any important production. In the Pacific Northwest, however, certain deposits, notably in western Washington, are believed to be of considerable potential importance commercially. A bulletin dealing with the economic possibilities of these deposits is being prepared by the Bureau of Mines.

Georgia is by far the leading producing state. There are no official figures of production, but according to estimates of several producers, the annual output is in the neighborhood of 15,000 tons, practically all of which comes from the Cartersville district, in Bartow County.

Georgia ocher has been used chiefly as a filler in the manufacture of linoleum and oil cloth, and much of it has been exported to England and Scotland for that purpose. Some of it is used for the same purpose in this country. It is also employed in the manufacture of paints, and in a variety of minor ways.

Pennsylvania ocher has been used principally in the manufacture of paints.

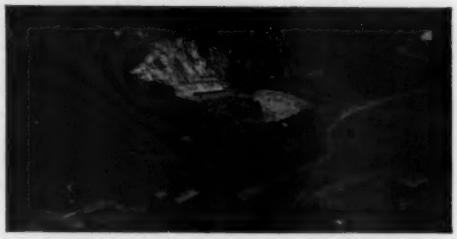
The preparation of ocher for market is ordinarily quite simple, involving merely a rough mechanical separation of the ocher from impurities that may be mixed with it. The sequence of processes is essentially similar in all districts and includes washing, drying, pulverizing, and packing. The purpose of washing is primarily to rid the product of sand, small stones, and other foreign matter which may be associated with the ocher in nature or which has been mixed with it in mining.

Further details are given in Information Circular 6132, "Ocher and Ochery Earths," copies of which may be obtained from the United States Bureau of Mines, Washington, D. C.

METALS

GUY N. BJORGE
Editor

Practical Operating Problems of the Metal Mining Industry



POWER for FANS for Metal Mine Ventilation

Use of booster fans becoming general—Pure air the best prevention of silicosis—Fan ventilation superior to use of compressed air lines in small mines—Complete fan installation cost paid in annual savings

By H. SPEIGHT * *and* W. D. TURNBULL †

VENTILATION of metal mines by the power driven surface fans and booster fans underground, or booster fans only assisting natural ventilation through shaft and drift is coming into more general use. The reason for this is the increased economy and efficiency together with the benefit to the health of the miner and general safety.

In some metal mines prior to the installation of small fans with doors, foul air conditions were experienced with certain wind conditions. Installation of a small fan together with the necessary doors in order to direct the air into the proper channels will remove the foul air which results in better working conditions for the miner and the tonnage per man is increased.

Copper mines having ore of high sulfide content may have difficulty with poisonous fumes after blasting. This hazard can be removed by following the coal mine practice of ventilation.

At some metal mines a surface fan is installed to force the air into the mine, allowing no outlet for the air except that found through the strata. This application is in mines where there is an occasional outflow of inert gases and this method of ventilation is used to force inert gases back into the strata.

A few metal mines have had methane gas conditions. To safeguard against this hazard, constant ventilation is a necessity.

Ventilation of the metal mine is due to the necessity of removing dust, fumes or gases and much thought has been given to the matter of securing greater

† Engineers, Westinghouse Electric & Manufacturing Company.

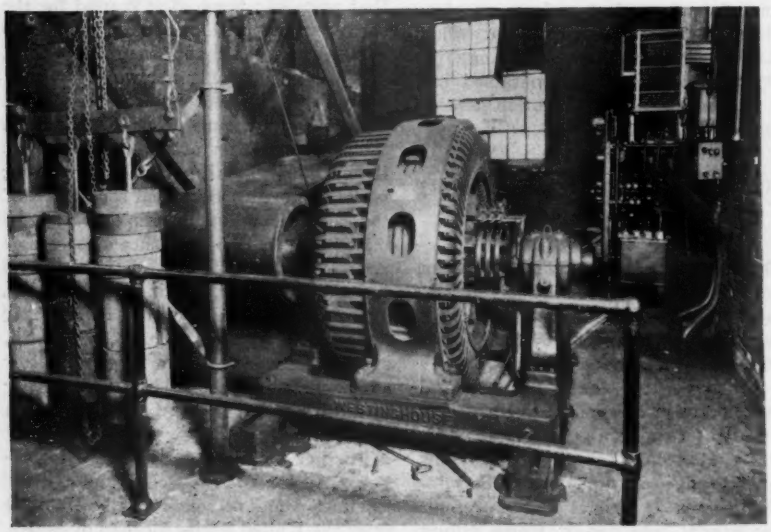


Figure 1—Synchronous motor driving a large mine fan

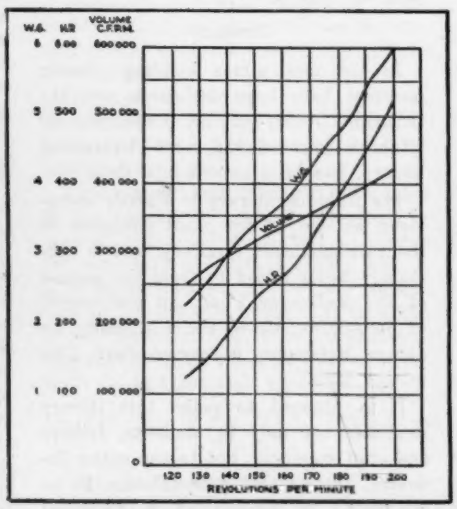
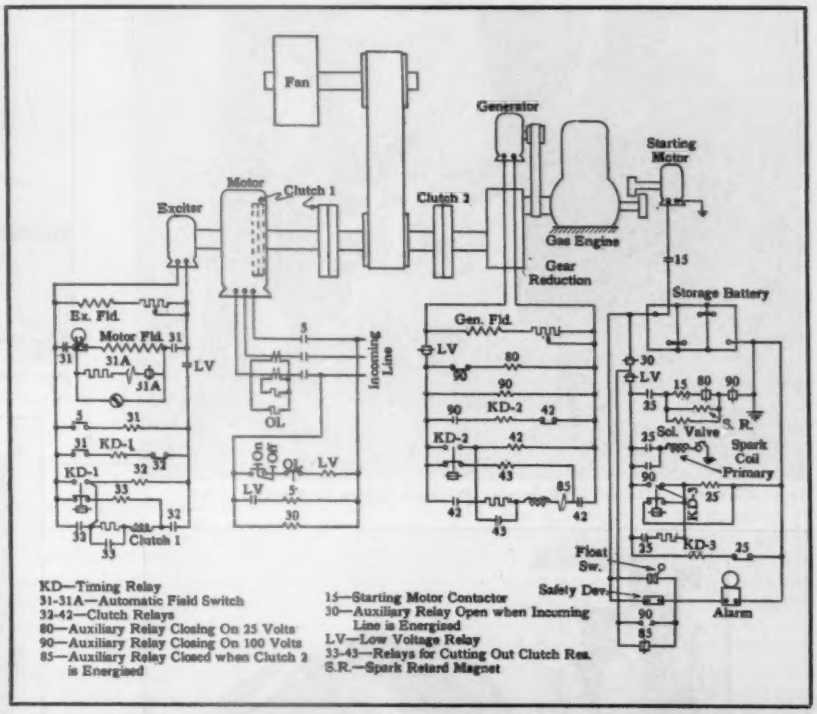


Figure 2—Characteristic curve of fan

Figure 3—Schematic diagram of automatic control of mine fan and standby unit



efficiency in hot working places. Health and safety have been receiving serious consideration as shown by the Ontario Government's action of including miners' consumption or silicosis as a disease for which damages can be obtained under the Compensation Act of the Government. One of the best safeguards against silicosis is an adequate supply of pure air.

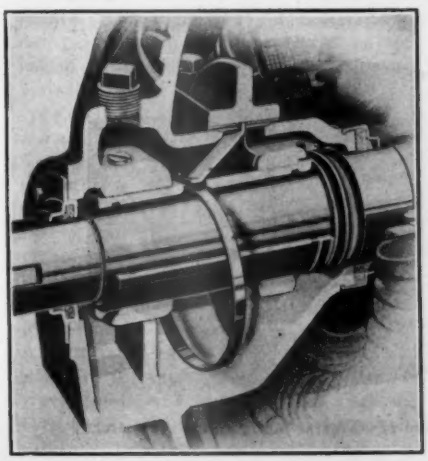
Main fans are usually found on the surface, electrically driven, so placed that the direction of air current may be reversed if desired. For underground distribution to faces, some mines use coal splitting system, but for the metal mines the use of small blowers with tubing to direct the air to the places most needed will give the best results.

The motor for driving the large surface fan may be of the synchronous type as shown in *Figure 1*. The modern synchronous motor correctly applied will have ample torque for starting a mine fan, and can be furnished with ample pull-in torque in order that the motor will synchronize when the fan attains full speed. When the conditions call for a large mine fan, operating 24-hours a day at constant load, it makes an ideal drive for the combined duty of mechanical load and power factor correction. When motors are operating under a constant load, a higher average power factor can be maintained. The characteristic curves of the fan driven by the motor, shown in *Figure 1*, is illustrated in *Figure 2*.

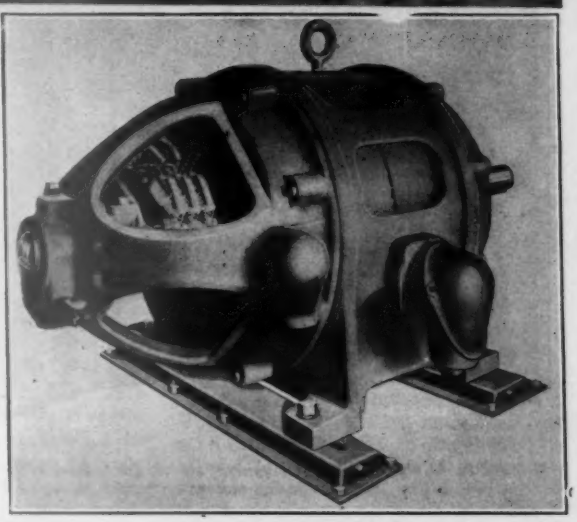
At mines where it is found essential to have standby equipment in case of failure of power supply, the standby equipment can be arranged to start automatically, as shown in the schematic diagram, *Figure 3*.

For the smaller installations of surface fans, the general application is a squirrel cage induction motor similar to that illus-

Above: Figure 4—Squirrel cage induction motor driving surface fan at a metal mine



Left: Figure 5—Modern type of sealed sleeve bearing



Right: Figure 6—Standard wound rotor induction motor

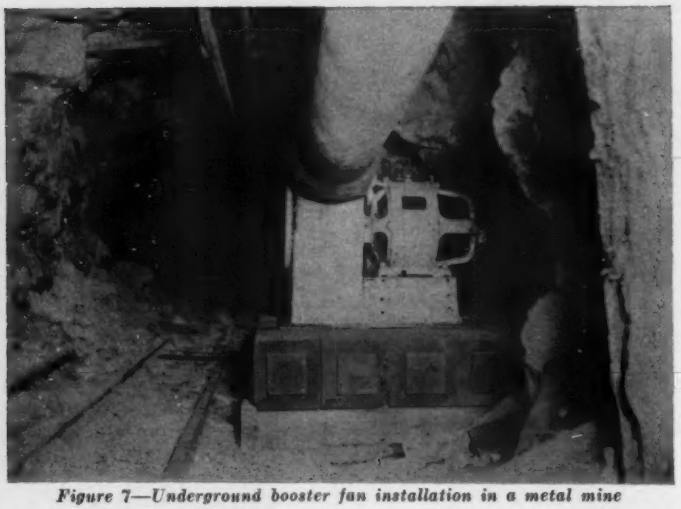


Figure 7—Underground booster fan installation in a metal mine

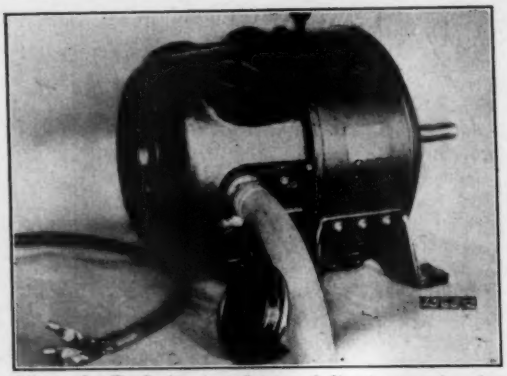


Figure 8—Explosion tested type of direct current motor

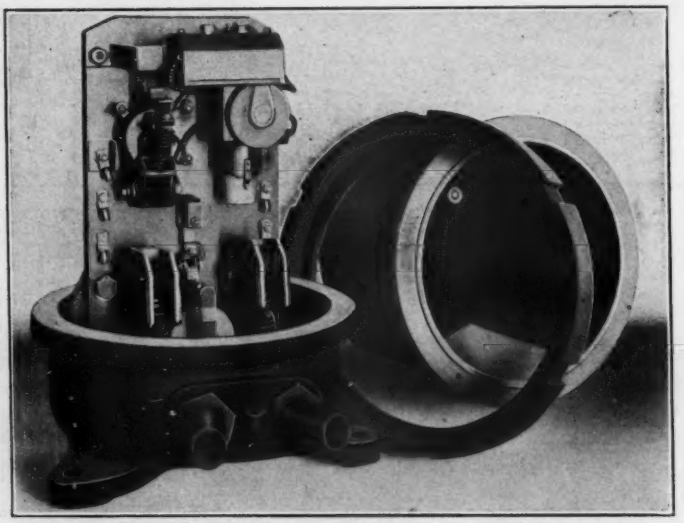


Figure 9—Special control for explosion tested motor

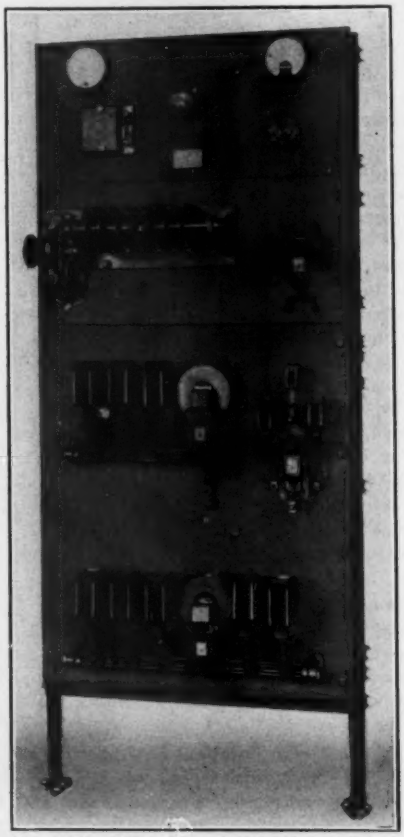


Figure 10—Magnetic reduced voltage starter for synchronous motor

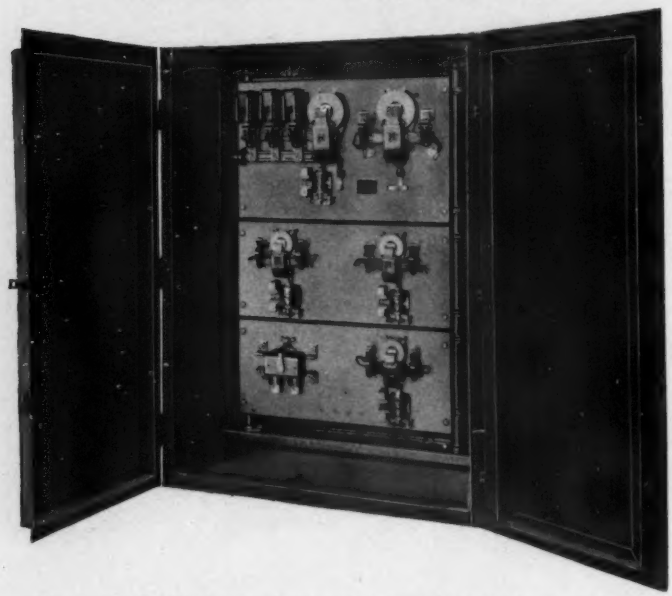


Figure 12—Enclosed type of magnetic starter for wound rotor induction motor

Figure 11—Starter for squirrel cage motor

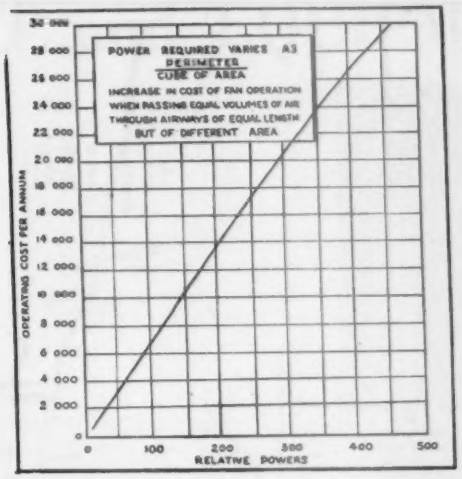


Figure 13—Curve of increase in operating cost equal volume of air passing through different area

trated in *Figure 4*. A smaller type of mine fan will usually be located away from much supervision, and the squirrel cage type of motor which is rugged and reliable rotating equipment is the ideal type of driving unit for this application. The modern squirrel cage motor with a sealed sleeve bearing which requires so little attention, only oiling once or twice a year, has proven to be very satisfactory in this service, *Figure 5*.

At some metal mines there is a desire to have a fan capable of running at reduced speed, and for this application the wound rotor induction motor is the most suitable, illustrated in *Figure 6*. This type of motor can be arranged to have three or four speeds for constant operation, which will be found ample for the application, and the capital investment will not be excessive.

Metal mines will frequently have 250 volt direct current on trolley locomotive hauling systems underground, therefore, it is natural that the small booster fan underground should be driven by direct current motors. *Figure 7* illustrates the usual type of D. C. motor applied to the booster fan drive in places where no gas or excessive dirt conditions have to be contended with. Where the conditions are such that gas may be expected or the booster fan will have to be located in a dusty atmosphere, the preferred application is the totally enclosed explosion tested motor shown in *Figure 8*. This type of motor is tested by the Bureau of Mines and is literally explosion-tested. The explosion test is made by filling the motor with an explosive mixture of natural gas, first inserting into the motor case a spark plug, seal the motor in the manner provided, then locate the motor in a steel chamber containing a similar gaseous mixture and igniting the gas by means of a spark inside the motor. A motor that has passed this test is satisfactory for applying to booster fan drive when there is a possibility of gaseous conditions. A special type of control usually applied with the explosion-tested motor is shown in *Figure 9*.

Where the underground trolley conditions are such that the trolley voltage does not vary more than 5 percent plus or minus a direct current motor, series wound, will be found the most suitable for this application. The series motor is a rugged piece of equipment and will permit of the simplest type of control. In cases where the trolley voltage will be varying 10 percent plus or minus, the motor for the booster type of fan, should be designed on the low part of the motor saturation curve, so that the variation in voltage will not appreciably effect the motor speed.

The motor for the booster type of fan will be 2-hp., 5-hp., or 7½-hp. The control equipment for the series type of motor can be just a simple knife switch.

The modern type of control for the synchronous motor is shown in *Figure 10*, the standard type of control for a squirrel cage when applied to a mine fan is shown by *Figure 11*, and that for the wound rotor induction motor is shown in *Figure 12*.

The mine fan installation for a metal mine is not an expensive item, when consideration is given to the advantages in economy, efficiency, health, and safety of the miner. All of the various types of motors outlined above will give very satisfactory and continuous service, the particular type of motor for the surface fan will depend upon the conditions at the mine. In many cases where no fan is installed, it is common practice to have an operating condition such as the opening wide of a 1-in. valve on high pressure air line after blasting. Examples of this have come to the writers' knowledge, where all blasting has been done on the graveyard shift resulting in a number of valves being open on the high pressure air system. This condition results in wasteful use of high pressure air for approximately 8 hours in every 24 hours. With power at 1 cent per kilowatt hour, the cost of this wasteful way of ventilation has often reached a figure of $50 per day. A far more efficient ventilating system could be obtained throughout every hour of the 24 with a power cost of under $4 per day, and the complete cost of the installation would be paid for in the power saving inside of one year.

The curve, *Figure 13*, illustrates the rapidly increasing cost of power to pass equal volumes of air along air ways of different areas, but of the same length.

Safety Instructors of Bureau of Mines in Great Demand

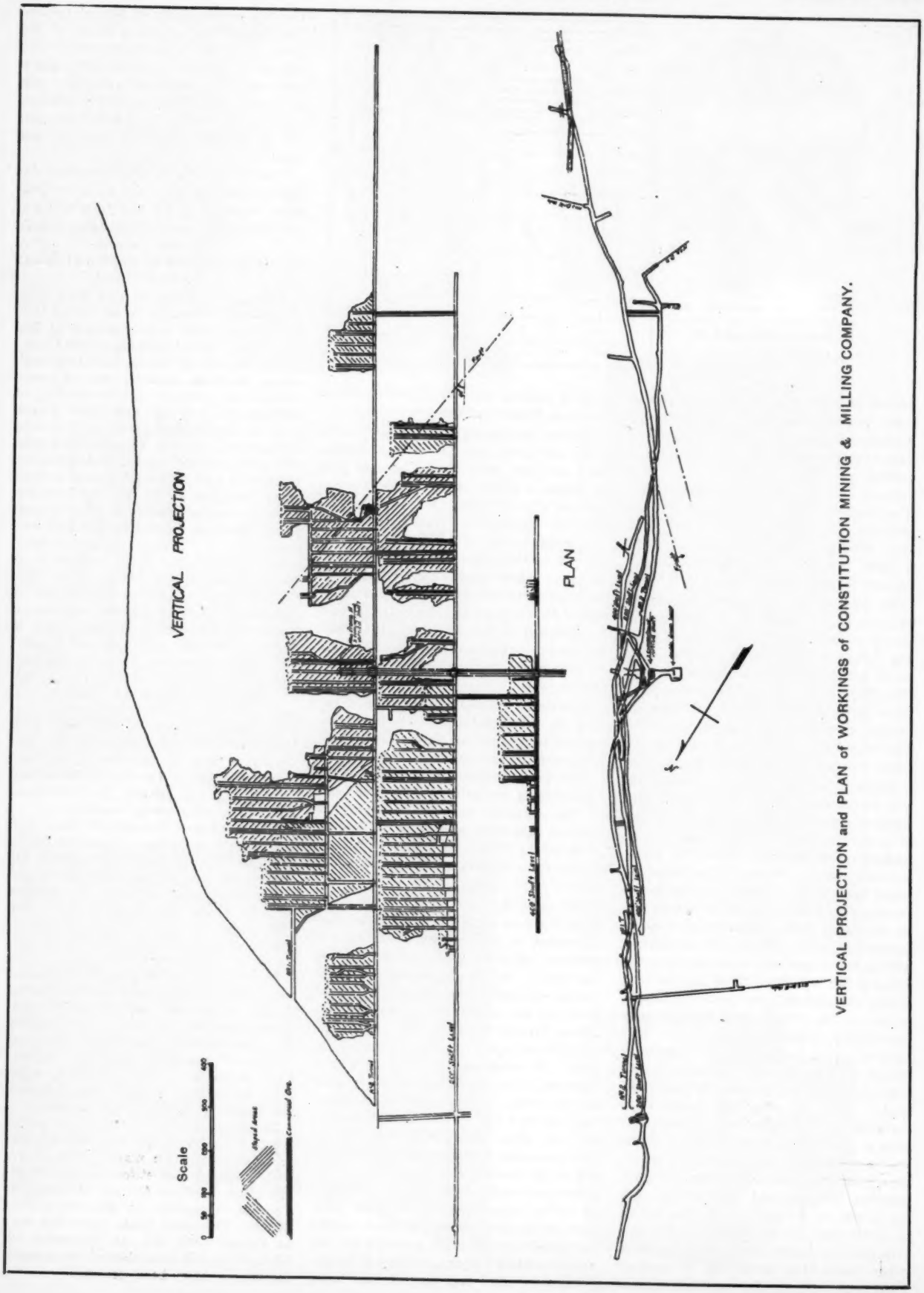
During the months of May, June, July, August and September much of the time and efforts of the approximately 60 field men of the Safety Division of the United States Bureau of Mines, including engineers, first-aid miners, and foremen miners, are given to the forwarding of contests in first-aid and mine rescue work in the various states and in connection with various agencies, including coal mining, metal mining and petroleum companies and organizations as well as other branches of the mining industry.

It is expected that before the contest season closes in September the field personnel of the Bureau's Safety Division will have participated, as trainers or as judges, in from 80 to 100 contests. The demand for the services of members of the Safety Division for the training of teams for the various first-aid meets is beyond the ability of the Bureau to comply in full. In many instances the field men of the Bureau are required to conduct day classes in some localities and night classes elsewhere in order to appease the insistence of those who wish their services. In some cases the Bureau field men, in addition to the team training work in the day in a certain locality, act as judges of contests at night in a neighboring locality.

The services of Bureau of Mines field men to act as judges at these contests are also desired to an extent which far exceeds the ability of the Bureau to assist; some contests have had the services of 5 to 15 of the Bureau's field men, and in order to comply it has been necessary that some of these men travel hundreds of miles.

In addition to training of teams for weeks before the meets, and acting as judges or as other officials at the contests, much of the time of the Safety Division workers is taken up in the preparation of problems, discounts, instructions to judges, etc., as well as in many other preliminary details connected with the handling of those various meets.

Much of the interest in these safety meets comes from the fact that winners of local contests in many instances are designated as competitors in the annual International First Aid and Mine Rescue Contest sponsored by the Bureau of Mines. This meet takes place this year at Kansas City, Mo., on September 12, 13, and 14, and a number of the competing teams have been selected.



VERTICAL PROJECTION and PLAN of WORKINGS of CONSTITUTION MINING & MILLING COMPANY.

NEW PLANT and EQUIPMENT at the Constitution Mine

By WILLIAM P. WHITE *

Three compartment vertical shaft supersedes slope development—Thirty cubic foot car loaded in four seconds by air-operated chute—Fine grinding essential for successful flotation—Simultaneous hoisting of waste and ore doubles mill capacity

Figure 4. Air operated chute gate at the Constitution mine

THE Constitution mine and mill are in the Yreka Mining District, Shoshone County, Idaho, and are situated on the East Fork of Pine Creek at its intersection with Gilbert Creek. The mine is two and one-half miles south of the property of the Bunker Hill and Sullivan Company, and is 15 miles by road from Kellogg, Idaho, and seven miles by road from Heim, which is the shipping point.

The ore bodies of the Constitution mine occur in a fault fissue vein which has an average trend of N. 33° W. and a dip of approximately 80° toward the southeast. Within this vein five ore bodies or shoots have been developed. The mine workings are shown in plan and section in *Figure 1.*

The mine has been developed by two tunnels, an inclined shaft and a vertical shaft. Two levels have been opened from the shaft. The main adit level was driven southeast on the vein for a distance of over 2,500 ft. Fifty feet north of the main adit entrance a one and one-half compartment shaft was sunk on the vein and the first level opened at 200 ft. below the adit level. On this level the first ore shoot was 500 ft. from the shaft and, as the ore shoot had a rake toward the south, this ore shoot would be 600 ft. from the shaft on a level 200 ft. deeper.

This inclined shaft was deemed unsuitable for further development of the mine for the following reasons:

(1) It was too small for use as an operating shaft.

(2) It was too far away from the ore bodies.

(3) An inclined shaft on the vein was considered unsatisfactory.

(4) Its use required costly work in straightening and retimbering the old shaft.

(5) It afforded only one point of attack in opening each new level.

For these reasons it was decided to sink a new three-compartment vertical shaft. This new shaft was located in the hanging wall of the vein at such a distance away that it will cut the vein at about 1,000 ft. vertically below the adit level. It is located 1,100 ft. south of the portal of the main adit and is a short distance south of the center of the known ore bodies.

The new shaft was started from the 200-ft. level (i. e., 200 ft. below the main adit level), and was sunk to the 400-ft. level where a shaft station and pockets were cut and opening of the 400-ft. level begun. The shaft was then raised to the adit level and a further distance of 80 ft. to provide head room. The arrangement of shaft station, headframe and cable raise, ore pockets and hoist room is shown in plan and section in *Figure 2.*

A double drum, heavy duty, electric hoist with a normal rope pull of 6,000 lbs. at a speed of 550 ft. per minute has been installed. The hoist is designed for a 150-hp. motor but for the present it is equipped with a 100-hp. 40-degree slip-ring hoisting motor. The larger motor will be installed when the mine requirements demand it. The new hoist and the arrangement of the underground hoist room is shown in *Figure 3.*

The ore pockets are equipped with air operated chute gates designed by the writer. These gates, illustrated in *Figure 4,* are very simple and efficient. They are operated from below the chute instead of from above and this prevents all spill. A 30-cu. ft. car may be loaded in four seconds. The gate is manufactured by the Coeur d'Alene Hardware and Foundry Company of Wallace, Idaho, and is known as the "White Air-Operated Chute Gate."

On January 21, 1928, fire destroyed the compressor plant and hoist at the inclined shaft. A 529-cu. ft. C. P. single stage compressor driven by a 100-hp. motor and a 35-hp. electric hoist were installed soon after the fire. Later an Ingersoll-Rand class P. R. E. 2, 5-step clearance control, with automatic control, was installed. This is driven by a 250-hp. synchronous motor and has a displacement of 1,574 cu. ft. of free air. The new compressor plant is shown in *Figure 5.*

Previous to the fire the water from the lower level was raised by an air-driven pump. This has been replaced by a Cameron multistage pump with a capacity of 300 gallons per minute under an 800-ft. head. The pump is direct con-

* General Manager, Constitution Mining and Milling Company, Masonia, Idaho.

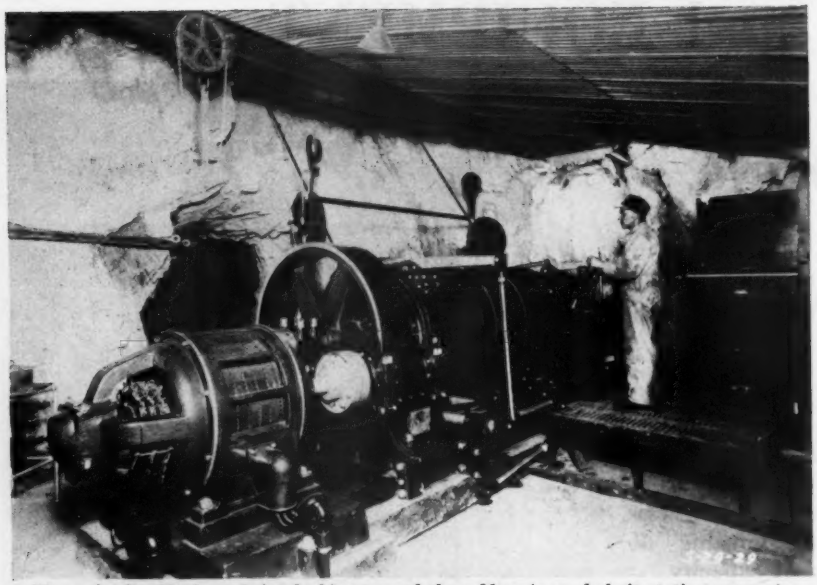


Figure 3—Double drum hoist, looking toward the cable raise and shaft station crosscut

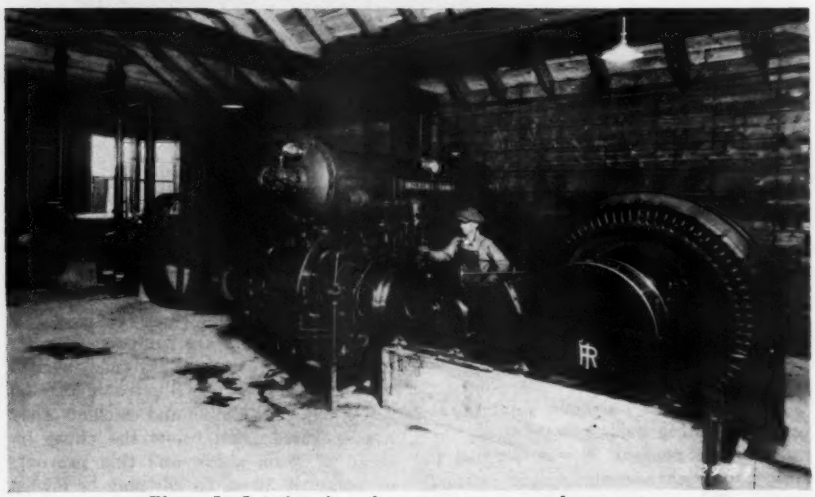


Figure 5—Interior view of compressor room and compressors

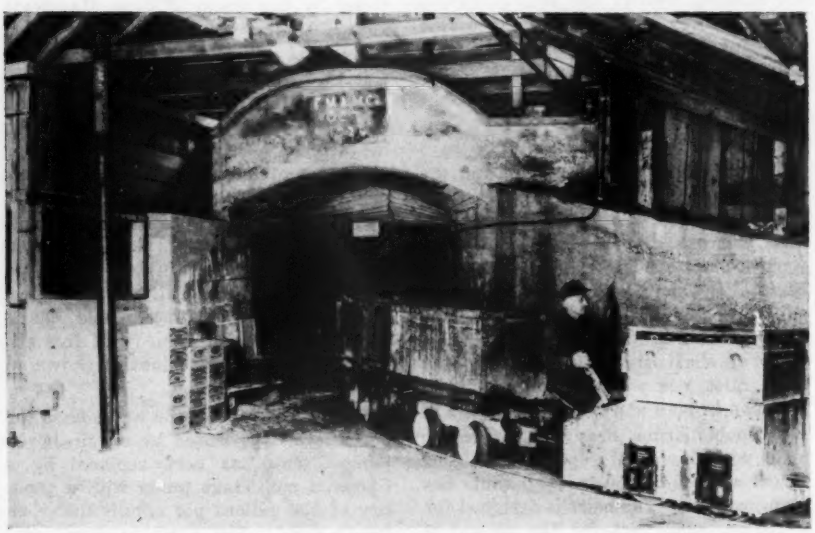


Figure 6—Portal of adit level, with Atlas storage battery locomotive and train of side-dump cars

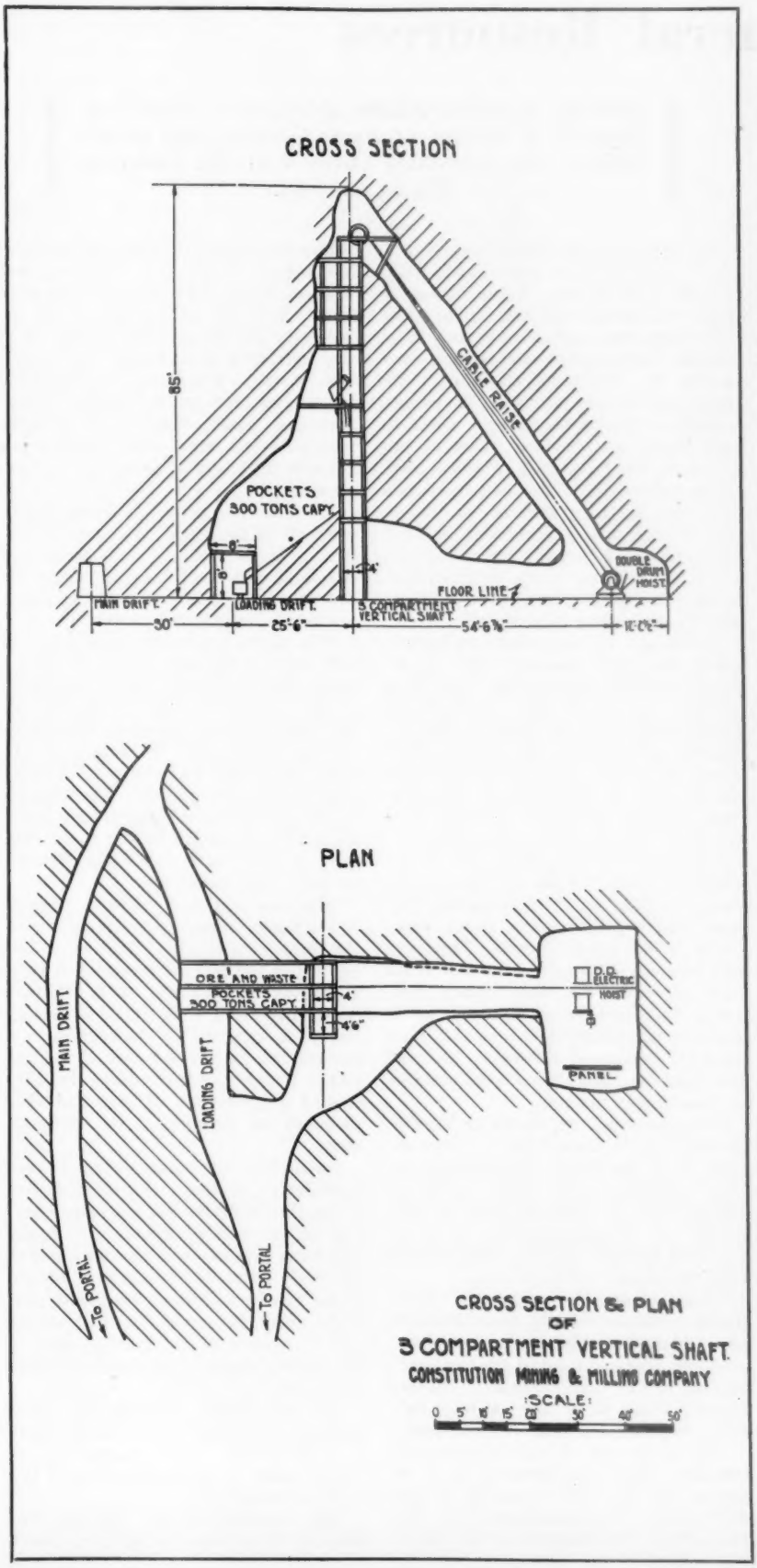
nected with a 150-hp. motor with automatic control. As the water in this district follows down after stoping, this pump will later be moved to the 800-ft. level.

Haulage on the main adit level is by storage battery locomotive. The equipment consists of one "Atlas" 2-ton storage battery locomotive with two sets of "Ironclad" batteries and a charging generator set. The cars used are 300-cu. ft. side-dump cars of the Coeur d'Alene type. Haulage equipment is shown in *Figure 6*.

The Constitution mill has a capacity of 150 to 200 tons in 24 hours. The mill was originally built for gravity concentration using jigs and tables but it has been remodeled and present treatment is by flotation. The flow sheet is as follows: Through 9 x 15 jaw crusher to 36 x 16 Blake rolls and from rolls to fine ore bins, thence to two 5 x 5 P. & M. ball mills with grate discharge in closed circuit with a classifier. The oversize goes to a Dorr classifier and the oversize from this goes to a Hardinge mill. The undersize from the P. & M. drag classifier and from the Dorr classifier is pumped by Wilfley and Krogh pumps to an Esperanza classifier for final classification. The oversize from the Esperanza is returned to the Hardinge mill and the undersize flows to a 30-ft. and a 40-ft. thickener. The ore is taken from the thickener at a density of 30 percent solids and is pumped to three surge tanks where it has a 40-minute contact with the reagents which are fed to the tanks by automatic feeders. The feed now goes to the flotation units which consist of three Owen Dalton, one K & K, three Hearing and one Fahrenwald flotation machines. The flotation concentrates go to a thickener and the quickened concentrate pumped by a diaphragm pump to a 5 x 10 latest type Oliver filter. The final concentrates contain 10 to 11 percent moisture. These are hauled by auto truck to Heim and then shipped by rail to the smelter.

Fine grinding is essential for good results and for this reason the mill is equipped with an exceptionally large ball mill for the tonnage handled. Screen analyses of the feed to the flotation machines shows about 95 percent to be under 200 mesh.

It is expected that the new equipment will result in substantial reduction in costs. The new compressor plant has sufficient capacity to carry on stoping and development work without interruption. The new three-compartment shaft with the new double-drum hoist will make it possible to handle waste from development and ore from stopes without delaying other work. The hoisting capacity will permit doubling the mill capacity as soon as that is warranted.



DIRECT SMELTING OF ZINC ORE

The direct smelting of zinc ore to liquid metal has at various times been essayed by zinc metallurgists, says the United States Bureau of Mines. Ambitious attempts, well financed, were made in 1906 and 1916, and the matter was privately considered in 1926. Technical literature near the former dates bears witness to the effort, care, and money expended on a process which was doomed to failure from the start. This case seems to have been one where lack of fundamental scientific and technical knowledge, rather than economic factors, was the source of failure; in fact knowledge of the physical chemistry of the reduction process was either lacking or wholly erroneous at that time.

In the course of its program of study of the fundamental properties of oxides and sulfides, the Bureau of Mines, at its Pacific experiment station, in cooperation with the University of California, has secured thermodynamic data which permit the construction, for the first time, of an authentic "constitution diagram" of the zinc-oxygen-carbon system. This diagram can be used to predict the chemical conditions under which the direct reduction of zinc oxide to liquid metal is possible. Had these data been available before the experiments of 1906 and 1916, the futility of the methods attempted at that time would have been evident, and literally hundreds of thousands of dollars might have been saved. The diagram further shows certain rather limited fields where the direct reduction is a physical possibility, and these limits, at least in one direction, run entirely within the bounds of practical possibility. The diagram and accompanying related data are soon to be published in detail by the Bureau of Mines.

CUBAN COPPER MINING METHODS

Data in regard to mining methods and costs at Minas de Matahambre, Matahambre, Pinar del Rio, Cuba, are contained in Information Circular 6145, just published by the Bureau of Mines. The Minas de Matahambre is situated on the north coast of Cuba, in the Province of Pinar del Rio, approximately 150 miles west of Havana. This mine is the only producer of copper in Cuba.

The circular contains: (1) a description of conditions determining the general method of exploitation such as the geology of the district and the physical characteristics of the ore and wall rocks; (2) a discussion in considerable detail of the methods employed under these conditions, including the methods of prospecting and exploration, sampling and estimation of tonnages, development, stoping, ventilation and management of labor; and (3) a summarization of costs.

Southern Mineral Resources

Institute of Public Affairs addressed by State Geologist H. J. Bryson, of North Carolina, and Henry Mace Payne, Consulting Engineer to The American Mining Congress.

AFTER concisely presenting the varied and valuable mineral and other natural resources of the South before the Institute of Public Affairs at Charlottesville, Va., Dr. H. J. Bryson, State Geologist of North Carolina, declared that the South must acquire an "industrial consciousness," and its people should become "industrially minded." He declared that as long as the South is content only with the production of crude materials, there is no hope for industrial expansion.

"There is no section of the United States that has a greater variety and more extensive deposits of minerals than the South," said Dr. Bryson. "We find every type of minerals from the precious stones down through to the common clays. Although the non-metallic minerals are by far the more important, yet we find large deposits of the metallic ores, many of which are being worked on a commercial scale. The resources of raw materials have scarcely been touched as compared with their variety and extent.

"The mineral production in the South began in earnest during the last war. In 1916 the total value of minerals and mineral products produced was $720,037,957, or 20.4 percent of the total produced in the United States. In 1927 the total value of production was $1,051,050,829, or 20.1 percent of the total produced in this country. In 1927 the total value of production had reached the enormous figures of $1,836,575,000, or 33.2 percent of the total in the United States. During the 11-year period from 1916 to 1927 the total value of the mineral production in the South almost trebled, while that of the entire United States did not double. The total value of production in the South in 1927 was practically equal to that of the entire country in 1910.

"In 1928 the South produced practically all of this country's supply of natural asphalt, barite, bauxite, fuller's earth, graphite, phosphate rock and sulphur. It also produced about 63 percent of the petroleum in the United States, or 43 percent of the world's production. The South produced in addition one-half of the clay, feldspar, lead, mica, zinc and over one-third of the country's coal supply.

"In summarizing the reserve mineral supply of the United States we find that the South has 5,020,000,000 barrels of oil, or 55 percent of the Nation's supply. It is estimated that the South has 571,515,000,000 tons of coal. These figures include bituminous, semi-bituminous, semi-anthracite, and anthracite coals. If we include lignite and sub-bituminous, there would be 600,000,000,000 tons. The South produces 94 percent of the natural asphalt in the United States. Kentucky and Texas lead in total value of this product. The production of carbon black from natural gas comes almost entirely from the Southern States, with Louisiana showing over 60 percent of the total. This industry is steadily increasing each year. In 1927 the South produced two-thirds of the graphite, with Alabama and Texas leading in production.

"Although no comprehensive investigation has been made to enable an accurate estimate of the quantity of iron ore in reserve, yet sufficient work has been done to give an estimate of 2,500,000,000 tons available above the 1,000-ft. level. This only includes the red and brown ores. If the magnetic, titaniferous and gray ores were included, there would be several million tons more.

"No one has attempted to give an accurate estimate of the manganese ore deposits of the South. It is known, however, that a great reserve exists, especially in Arkansas, Georgia, Tennessee and Virginia. During the last few years new processes for beneficiating low-grade ores have been invented which makes it possible to work ores that were formerly considered worthless. Many of the Southern States have large reserves of these low-grade ores.

"The aluminum ore, known as bauxite, produced in the United States comes entirely from the South. Arkansas is the chief producer, with small quantities coming from Alabama, Georgia and Tennessee. No estimate is given of the reserves of bauxite, but it is reported that they are large.

"The lead and zinc production of the South comes principally from Missouri and Oklahoma. These states in 1927 produced over one-third of the total production in the United States. The reserves are said to be large, at least sufficient to last for several years to come.

"The production of salt is increasing annually. Louisiana produces about 80 percent of the total produced in the South, with Texas second and West Virginia third. The reserves in these three states are unlimited. One salt basin, beginning in Texas and continuing into Kansas, is 700 miles long and 300 miles wide. It is one of the largest salt deposits in the world. Many of the chemical industries depend upon the production of salt. The industries consuming large quantities are the leather, textile, fertilizer, paper, soap, food products, vegetable oils, glass and ceramics and the manufacturers of soda ash and caustic soda.

"In 1928 the South produced practically all of the domestic supply of sulphur. Texas produced 99.9 percent of the total and Louisiana the remainder. The sulphur deposits of these two states are said to be the largest known.

"The barite production in the South in 1927 was 90 percent of this country's total. Six of the Southern States have shown a production in the past and all have large reserve supplies. The South also produced over 98 percent of the total phosphate rock output. Florida alone produced 82 percent. The total reserves of phosphate rock in the South are estimated at 318,300,000 tons. The chief deposits occur in Florida, Tennessee and South Carolina.

"The clay and clay products industry of the South is rapidly becoming one of the most important industries. The South has the largest reserves of high-grade clays in the world. It is said that one county alone in Georgia has enough clay if it were put on the market in a refined state to pay the cost of the late war. Every Southern State in 1927 showed a production of clay and they produced 50 percent of the domestic clays.

"In 1927 every Southern State showed a production of stone. No other section of the United States has a greater quantity of building stone than the South. The finest granites and marbles found in the world occur distributed over several of the Southern States. The South produces about 42 percent of the granites and 57 percent of the marbles used in the United States. The supply of these materials is unlimited.

"In 1927 Florida, Georgia and Texas produced 76 percent of the fuller's earth in this country. The occurrence of fuller's earth is reported in nine of the 16 Southern States.

"The portland cement industry has materials is unlimited. (*Cont'd on p.* 617)

© Harold Gray

A September sunset from one of Washington's beautiful driveways.

MECHANIZATION REPORT No. 29-2

Methods *of* Pillar Recovery *With* Mechanized Loading

By G. B. SOUTHWARD

THIS report describes methods of pillar recovery with mechanized loading as operated in the room and pillar system and will show several typical mining plans, developed for mechanized loading, that are operating successfully and in a systematic manner to recover a high percentage of coal. These plans will not include methods with long face mining since long face work will be covered later in a separate mechanization report.

Since the advent and adoption of mechanized loading in coal mines there have always been some operations in pillar recovery with mechanical loaders, scrapers and conveyors but the far greater proportion of this equipment has been used in working rooms and entries. There have been three main reasons for this. *First*, the application of mechanized loading to entry and room driving was not complicated by any problems of roof control. *Second*, there was some hesitation in installing and operating expensive loading equipment under the more hazardous roof action in pillar extraction. *Third*, a large part of the earlier development of mechanized loading has been in certain fields where pillar recovery has not been practiced on any wide scale even with hand mining. While these three factors have served to lead the adoption of mechanized loading toward entry and room work they have not prevented operations in pillar recovery and there are now a number of mechanized mines where some pillar mining is being done.

A recent survey of 100 successful mechanized loading operations in the room and pillar system using all four types of loading equipment show about 50 percent as reporting pillar recovery. Of these operations, 20 are with conveyors, 17 are with mechanical loaders, 8 are with pit car loaders and 6 are with scrapers. These figures are not indicative of the tonnage mined and are in no sense intended to imply that 50 percent of the tonnage mined by these operations was from pillar work. In fact, quite the reverse is true as a very large portion of the coal mined with mechanized loading in the room and pillar system is from entries and rooms. However, these figures do show that there is quite a distinct trend toward pillar recovery with all types of mechanized loading equipment.

These pillar operations are quite variable in their general plan, their methods of operation and percentages of recovery. In some cases the pillar work is not well systematized and consists of a comparatively small amount of slabs or crosscuts which merely reduce the size of the pillars to a point where small local falls may occur but where no general surface subsidence takes place. This practice is found more with loading machines and with pit car loaders. Other mines are using scrapers and conveyors to recover the standing pillars in panels where the room mining has been done with hand loading and such operations have proved effective and economical, especially where the top has fallen to such an extent that it would be prohibitive to clean roadways for mine car tracks. However, neither of these two types of mining are being considered in this report and the descriptions and plans which are shown here are confined to methods of pillar recovery where a high percentage of extraction is made and where the pillar work is systematized and carried on as a part of the regular mining operation.

According to the mechanization census pillar recovery in the room and pillar system has made more progress with conveyor mining as a whole than with the other types of loading equipment. This is because conveyors have been installed in fields where a high percentage of coal extraction was compulsory and because they are also used to quite an extent in low coal where a maximum mining area from one set-up is necessary to justify an installation. Mechanical loaders, on the other hand, while proven efficient for pillar recovery have largely operated in fields where standing pillars were required to protect the surface. Scrapers have had a wide application in low vein anthracite mines and pit car loaders are now being found very effective for pillar work in medium and high coals.

The sketches which are shown in Figures 1 to 5 include three operations with mechanical loaders and two with conveyors; all are in actual operation and have been working successfully for some time. Figures 1 and 3 are similar, in general, to plans that are used quite extensively with hand mining except that with mechanized loading the work is much more systematized. The plan in Figure 2 was designed especially for mechanical loading and the conveyor operations in Figures 4 and 5 are distinct departures from hand mining plans and practices.

In Figures 4 and 5 the method of working only one or two rooms at a time, confined in a small space between solid coal and a caved area, has simplified the roof problem to quite a degree as compared to the general hand mining plan where the pillar line extends across a large territory. In these two operations more than one cut is taken during a shift and a usual record is to drive a room and complete the pillar in about one month from the time that the room neck is started. This rapid rate of mining tends to eliminate roof trouble caused by deterioration of timbers, coal pillars, or top strata and is a further favorable recovery factor. In all five of these plans a satisfactory recovery is reported with mechanized loading, and in Figures 4 and 5, particularly, the percentage of extraction is said to be much higher than that made with hand mining.

Pillar mining is naturally more difficult than room or entry work. The roof support requires some labor and the roof falls cause interruptions or at least serve to retard the operation. More care must be exercised in cutting, timbering and loading. These difficulties are being overcome and it is estimated that an average of the performances now being made with mechanized loading in pillar recovery would show that the same crew and the same equipment when working on pillars will produce about 75 percent of the tonnage mined when working in rooms.

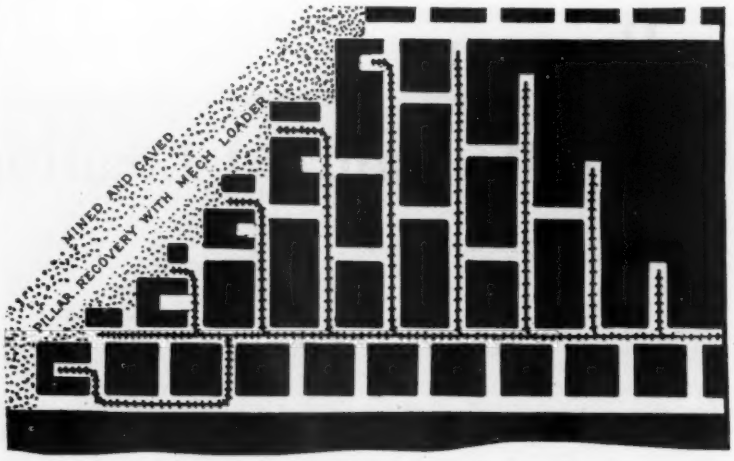


FIGURE 1
MINING PLAN
FOR BLOCK PILLAR RECOVERY
AS USED WITH MECHANICAL LOADING

FIGURE 1 shows a modification of room and pillar mining which is known as the block system. This method was originally developed for hand loading but is now being adopted for mechanical loading. In this plan the greater proportion of the coal is mined from the pillars and the first mining consists of narrow rooms and crosscuts which develop the panel into square or rectangular blocks. The rooms are driven about 15 ft. wide, with centers varying from 75 to 100 ft.; this blocks the coal into pillars from 60 to 90 ft. thick.

The method of recovering the pillars will vary according to conditions. In some cases open cuts are made across the end of the pillar. This is approaching long face mining and allows several cars to be placed at one time. This is a distinct advantage with mechanical loading but in some mines the difficulty of holding the faces open from roof falls has prevented its use. In other mines the pillar is recovered by crosscuts driven at right angles through the block and leaving a small stump next to the gob area which is recovered by longitudinal slabs or short open-end cuts. With the crosscut method a fairly high concentration can be had by working two places in each block; one advancing while the other is recovering the stump.

This method has been found very effective in mines where the top is not particularly good and there is difficulty in holding the roof in wide rooms. It has also been adopted in mines with heavy cover where the narrow rooms and wide pillars provide a greater support for the roof weight than the usual method of driving wide rooms with narrow pillars.

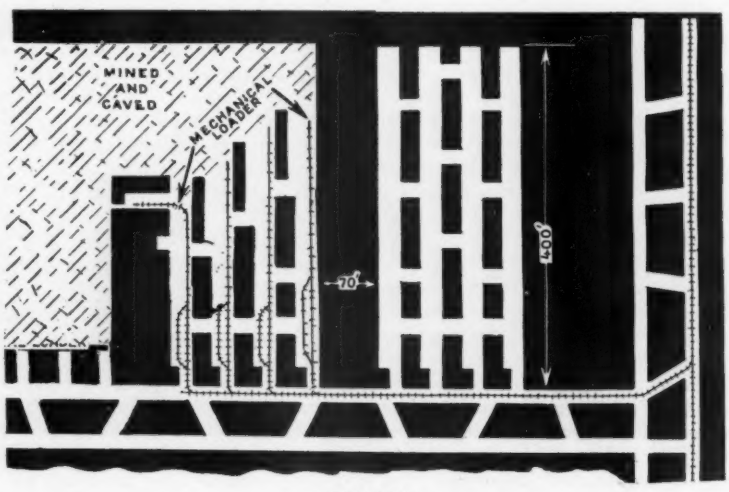


FIGURE 2
MINING PLAN
FOR ROOM PILLAR RECOVERY
DESIGNED FOR MECHANICAL LOADING

FIGURE 2 shows a room and pillar system of mining which has been designed and developed for mechanical loading. The rooms in the panel are worked advancing and the pillars are recovered retreating; using mechanical loaders in the entry development, the room advancement and the pillar recovery. The rooms are driven 28 ft. wide on 50-ft. centers and 400 ft. long and are advanced in blocks of four, leaving 70 ft. of solid coal between adjoining blocks.

The recovery is confined to one block at a time and a set of four rooms together with the 70-ft. solid pillar are mined out down to the entry before the next block of pillars are started. The room pillars are mined by slab cuts paralleling the track and a cut is usually made about 60 to 70 ft. long from one breakthrough to another. The 70-ft. pillar is mined by crosscuts and pockets with a track turn laid as required.

This method localizes the roof action to a comparatively limited area and is used successfully under medium and light cover. The 70-ft. block has proved very effective in breaking the top after an area has been mined and very probably serves to carry a large proportion of the local weight and to relieve the room pillars from heavy pressure while they are being slabbed. There is a certain amount of coal lost in pocketing the 70-ft. pillar and it is usually not practicable to completely slab all of the room pillars. However, a high percentage of coal is reported where this method is used.

FIGURE 3

Mining Plan
used for
Room Pillar Recovery
With Mechanical Loading

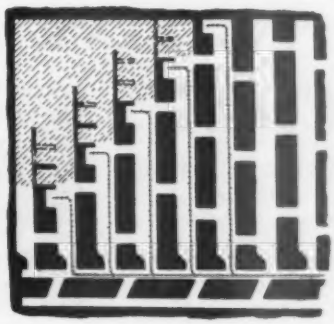


FIGURE 3 shows a method of pillar recovery used with mechanical loading which is very similar to hand mining methods. The room widths vary in different localities from 20 to 30 ft. wide; ordinarily about 50 percent of the coal is taken in the first mining, leaving 50 percent in the pillars.

As is shown in the sketch the pillars are mined by a series of pockets which are driven at right angles to the room length and are usually driven approximately room width. These may cut entirely through the pillar but more frequently a small rib of coal—about 5 ft. thick—is left next to the gob area and there is also a thin pillar usually left in between adjoining pockets. These pillars serve as a protection to the working place and their subsequent recovery is determined by the condition of the roof and the amount of roof weight.

A single track is laid to the face and the car changes are made one at a time either by mule or gathering locomotive as in the regular room advancement. It is customary to work only one pocket at a time in each room pillar although some operations may neck a few places in advance to provide extra coal for loading when needed on any shift.

FIGURE 4

Mining Plan
For Conveyor Operation
With Double Rooms
and Pillar Recovery

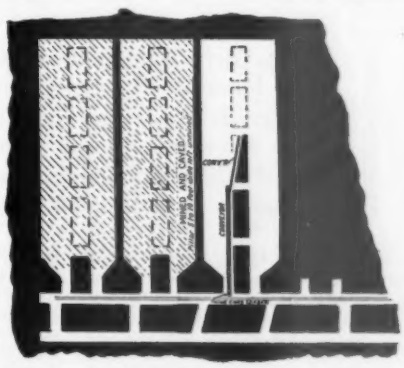


FIGURE 4 shows a mining system developed for conveyor operations. In this plan two rooms are taken as an operating unit and are advanced abreast. As soon as they have been driven up the pillar between is recovered immediately. The dimensions vary in different localities but the usual trend is toward wide rooms—from 30 to 40 ft. with the pillar about one-half of the room width. The pillar is mined from one side with a tapering slab cut. A short conveyor is laid parallel to the working face and discharges onto a haulage conveyor laid down the room to the entry. In some cases the pillar is recovered by open-end cuts but the advantages of the long angle slab make this method preferable where it can be used.

In mining the pillars the top is held on timbers until sufficient weight has developed for a cave. In some rooms no fall will occur until the pillar has been completely mined out down to the entry; in others there may be two or three breaks during this period. The falls usually stop at the pillar which is being mined and the slabbing can be continued without the necessity of opening a new face. In driving rooms, a thin pillar is usually left along the gob side next to the mined area to serve as a roof support during the room advancement. This is not large enough to withstand the weight of the overburden after the room pillars have been mined and it will subsequently crush out allowing a complete cave to occur.

FIGURE 5

Mining Plan
For Conveyor Operation
With Single Rooms
and Pillar Recovery

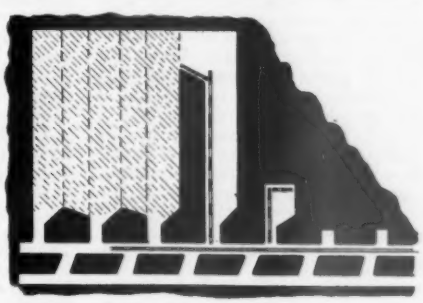


FIGURE 5 shows a method of room mining and pillar recovery which is used quite extensively in conveyor operations. In this plan the recovery is an essential part of the system and the pillar is started back as soon as the room has been driven up. The width of the rooms vary under different conditions from 30 to 40 ft. and the pillar will be from two-thirds to full room width. The room length varies from 250 ft. in 3-ft. seams to 300 ft. or 350 ft. where the coal thickness is 4 ft. or greater.

As shown in the sketch the pillars are mined open-end and are usually cut on a slight angle. The cut may be taken across the entire end of the pillar or in some cases a thin rib of about 5 ft. is left in next to the mined area. A short conveyor is laid along the face discharging onto a haulage conveyor laid down the room to the entry.

Timbers are set after each cut and the general practice in this method is to hold the roof on timbers as long as possible rather than to remove timbers and attempt to cave the top after each cut. A retreat of from 50 to 100 ft. is frequently made before a roof fall occurs. This may or may not close the working face but where this does happen a comparatively small time is required to reopen. After several rooms and pillars have been mined at the top of the panel and the first large cave occurs there is little difficulty experienced from roof weight in the rest of the panel.

COAL

NEWELL G. ALFORD
Editor

Practical Operating Problems of the Coal Mining Industry

Modern STRIP MINING in North Dakota

Lignite strip mining developed during the war—Modern equipment now producing high grade fuel—Special methods of handling in winter—Four sizes marketed—Skilled miners trained from common laborers on graduated wage scale

By A. H. TRUAX*

NO GATHERING of old timers in northwestern North Dakota is quite complete without the story of the homesteader who for years dragged his coal across the prairie 30 or 40 miles from the nearest railroad and then one day dug a cellar under his house and found a seam of lignite 6 ft. below the surface. Such cases, while perhaps not as common as the stories would indicate, at least occurred with enough frequency in the early days to establish the fact that with some exploration and a little combined effort amongst the farmers of various communities small lignite strip pits could be opened at a very small cost which would supply the neighborhood fuel requirements. As these farmer pits were invariably opened at the point of low overburden and naturally on the outcrop, the quality of coal obtained was inferior, and the coal so obtained was for a number of years not considered as a commercial factor in the coal production of the state.

Shaft mining of lignite dates back to the early nineteen hundreds in North Dakota, but strip mining, other than the small farmer mines before mentioned, did not appear on any scale until war time. Stimulated by the abnormal demand during the war, several of the farm pits made an effort to increase their production, and various types of weird stripping equipment made their appearance. These were mainly adaptations of drag-scraper ideas, home constructed and often horribly inefficient. In the Columbus Field also appeared one antiquated standard railroad steam shovel, the first power shovel to be used in stripping North Dakota lignite. The repairs necessary for keeping this shovel in operation proved to be too heavy a burden for the owner, and its use as a shovel was soon discontinued, its machinery was dismantled and adapted as a power unit for a drag scraper. This period marked the introduction of road-grading machinery into the lignite stripping and 1918 found several contractors at work with elevator graders and dump wagons opening up small pits in the Columbus Field.

The summer of 1919 found the first successful power shovel installation. At that time the newly organized Whittier-Crockett Coal Company purchased for their operation in the Columbus Field a Marion model 36 steam shovel. This machine, although purchased primarily with the view of loading the coal from a pit which had been stripped by elevator grader method, was found valuable in extending the stripping and clearly demonstrated in its first season that only by the use of power-stripping equipment could production costs be brought to a level which would warrant expansion.

Prior to 1922 lignite consumption in North Dakota was confined to a small territory adjacent to the mines. Most of the lignite on the market was of indifferent quality, very little attention was paid to preparation, and marketing did not take into consideration any other outlet than domestic use. Lignite was a poor relation; something to be mentioned in its own territory in an apologetic tone and decidedly out of the picture with coal buyers beyond a radius of approximately 150 miles from the mines. Furthermore, while the coal trade looked at all lignite with a disapproving eye, it turned an icy shoulder to a product reported as mined from a strip pit. Popular opinion still took into consideration the man who found a lignite mine in his cellar. All strip coal was supposed to be mined "amongst the grass roots." Anyone knew that quality came from under deep overburden.

During these early days two companies had been establishing a footing in the strip pit field. These two concerns, the Whittier-Crockett Company, before mentioned, and its neighbor, the Truax Coal Company, both operating in the Columbus Field, had passed from the elevator grader stage to the point where they were both using small revolving shovels for digging both overburden and coal. A moderate sized dragline had made its appearance, tipples with shaker screens had replaced hand shoveling into the cars, and small sales organizations were attempting to convince the trade that strip coal which came from under 25 ft. of overburden was of fully equal quality with coal from a shaft of approximately the same depth. Slow, up-hill work certainly, but the foundation of operations which were ready to expand with the development of demand. This demand came with a rush in 1922.

The first few months of the strike in 1922 did not excite the North Dakota coal trade. Dakota does not buy coal in the spring and summer. However, the handwriting was on the wall in sight of the operators in the lignite fields. The demand was coming, and it was time to expand to meet the expected business. The first large stripping shovel, a 175-B Bucyrus, arrived at the Truax mine, followed shortly by a Marion 300 on the Whittier property. Midsummer brought the first results of the strike by unprecedented summer buying. North Dakota retailers as a whole suddenly accepted lignite as their own. Minnesota turned its eyes toward this heretofore unrecognized source of supply. Twin City coal buyers looked with apprehension at dwindling supplies in the East and transferred their interest, for the

*Vice President, Truax-Traer Coal Company, Elkville, Ill.

time being at least, to this "Little Anthracite of the Prairies." And at last certain industrials and public utilities groaned at the prospect, but placed tentative trial orders with the lignite companies. Then further amazement. This product of the northwest proved itself to be not entirely "commercial mud." It burned, produced heat, was found in most cases to be well prepared, entirely free from impurities, clean. Forced on the market, lignite remained, a prominent factor in the fuel supply of the northwest. Not all of the territory won during the strike was retained. Governing freight rates set up a line beyond which this low heat fuel may not be economically shipped. However, almost overnight the field of lignite consumption was more than doubled, and because of ability to readily meet additional demand, the strip mines came into their own. Since the time of the strike, the industry has moved steadily forward. Industrials and individuals, recognizing the value of this product found at their own back door, have experimented and found particular types of equipment especially suited to the burning of this fuel. State institutions use lignite exclusively. Lignite screenings, which for years were hauled out to burn in smouldering waste piles, now furnish the state with power and light. And the householder, figuring on the heating requirements for his new home, now purchases a furnace with increased grate area especially adapted for the burning of this native fuel.

To get at the special problems confronting the lignite strip operator in the North Dakota field, it is necessary to look into the nature of the fuel itself. An average analysis of the lignite mined in the northern North Dakota field is as follows:

Moisture	32.00%
Ash	6.00%
Fixed carbon	33.00%
Volatile	29.00%
B. t. u.	7,200
Sulphur	.05%

The high moisture content is, of course, the joker in the situation. The coal can not be stored over long periods except in tight bins. This results in a seasonable market, the movement of coal commencing in the early fall, reaching its peak with the coming of cold weather and running for a period of about five months, after which it drops off almost entirely through the late spring and summer. Due also to this high moisture, shipment in open cars is impossible for all grades except screenings and tipples must be equipped for box car loading. The combination of severe winter weather and excess moisture in the coal itself presents the problem of handling frozen coal during the greater portion of the loading season and necessitates special arrangement of tipple screens and conveyors.

While the seasonable market for lignite is unfortunate from the standpoint of the operator, it works strictly to the advantage of the strip mines as compared with shaft properties. The shaft operator faces the absolute impossibility of being able to keep labor employed during the entire year. With the strip properties, effort is made to uncover the bulk of the coal required during the favorable months of the spring, summer and early fall, and most of the labor can be shifted from the coal loading to the stripping and back again as may be required, so that there is almost constant employment for all classes during the entire year.

For a picture of strip operations in the Dakota lignite field, the properties of the Truax-Traer Coal Company are offered as being most widely distributed and covering varying conditions. This company has formed a combination of the leading properties in the Columbus Field, with the addition of a large unit at Velva, situated at the eastern extremity of the now known lignite deposits. The company is producing approximately 550,000 tons of lignite annually, and through its location on two of the leading railroads of the northwest is in position to serve probably a larger territory than any company now operating for the production of lignite coal.

In the Columbus Field, the company is working a seam of about 8½ ft. in thickness under a cover ranging from 20 to 50 ft. The coal seam is continuous without parting of any nature and is absolutely free from rock or slate. The cover consists of clay and shale, all of which may be dug without blasting and which will stand without caving from one season to the next. With these conditions, it is possible to strip a full season's requirements of coal in advance of the loading. The coal may be dug without shooting. The stripping equipment in this field consists of one model 300 Marion steam shovel and one model 175 Bucyrus steam shovel. Two model 50-B Bucyrus steam shovels and one 50-B Bucyrus electric shovel are used for the coal loading and one Northwest Diesel combination dragline and shovel is used for general work, such as grading, ditching and rehandling screenings. Five 14-ton Plymouth gasoline locomotives, equipped with 18-ton motors, and 4-ton side dump cars are used for the coal hauling from the pits over 36-in. gauge track, while the company owns and operates 7 miles of standard gauge track and 2 standard gauge steam locomotives for switching cars from the mines to the main line of the Great Northern Railway. Two tipples are in operation, one built by the Link-Belt Company of Chicago and one by the Ottumwa Company of Ottumwa, Iowa. The combined capacity of these tipples is approximately 6,000 tons per 10-hour day. Box car loaders of the conveyor belt type are used for all grades of coal.

Stripping shovels operate in separate pits at the Columbus property, the general layout being that of a horseshoe, arrangements being made so that coal can be loaded over both tipples if necessary or over one when market conditions so allow. Ordinarily stripping shovels work two 10-hour shifts, each 24 hours. Operators are made responsible for the upkeep of their machines and are required to supervise all repairs. Service recorders are installed on all shovels and yardage is carefully checked. The coal loading is carried on in 10-hour shifts normally, although during the peak it is not uncommon to run the tipples 12 and 14 hours per day.

The Velva property has the added advantage of a 14-ft. vein of coal under cover of approximately the same depth as at the Columbus mines. Conditions as to overburden and nature of the coal are very similar. This property operates with a model 320-B Bucyrus electric shovel as a stripping unit, one model 50-B Bucyrus electric shovel for coal loading and one model 50-B Bucyrus Diesel shovel as a general purpose machine. Four Plymouth 14-ton gasoline locomotives are used for coal haulage with 4-ton solid cars, which are used with full rotary dump at the tipple. The company here operates 10 miles of standard-gauge railroad and 2 steam locomotives for switching cars to the main line of the Soo Railroad. A Pittsburg Boiler and Machine Company tipple equipped with crusher forms the loading unit.

The Dakota coal market regularly calls for 4 grades of coal, 4-in. lump, 1-3/4 x 4 egg, ¾ x 1¾ nut and screenings. The lump is the big domestic fuel and can not be too lumpy and coarse to suit the demands of the Dakota farmers. To increase the percentage of the lump, the company has developed the use of a forged pick point dipper tooth on its loading shovels. By the use of this tooth it is possible to load better than 50 percent of the coal as 4-in. lump. Screenings were, up to the last four years, almost complete waste at the lignite mines. Development of boiler equipment and mechanical stokers have now rendered this valuable fuel. The market is not large enough to take care of the screening output during the peak of the loading, but will take all available supplies throughout the year. The company has arranged for screening storage near its tipples so that reloading may be handled at a minimum expense with small shovels and traps. The screenings store nicely and may be loaded in open top cars for shipment. Water conditions in the lignite fields are bad, and in the early days great trouble was experienced in connection with steam locomotives used for coal haulage. The introduction of gasoline locomotives into the fields solved this problem and greatly increased the efficiency of the operations. By the use of over-sized motors with the lighter locomotives more speed has been developed and track maintenance has been kept at a minimum. Because of bad water and the additional disadvantage of operating steam machinery during the extreme cold weather, the company's tendency is to replace all steam equipment with electrically operated machines. However, present steam machinery must be used and the special problems of keeping water lines and lubricants flowing at temperatures as low as 40 degrees below zero have been encountered and now offer no great handicap to the loading and stripping of coal.

The lignite fields operate with non-union labor. While daily wages are considerably below the union scale, the factor of steady employment in the strip mines raises the yearly realization of the employes considerably above the average and there is no dissatisfaction. Common labor is regularly employed by the Truax-Traer Company at $0.40 per hour. After one year of service the rate is increased to $0.50. While there is no increase for common labor beyond that point, it has always been the policy of the company to develop its skilled employes from its common labor. That this has been accomplished is evidenced by the fact that practically every highly paid position in connection with the operations is filled by a man who started with the company as a common laborer. Labor turnover is very light, many of the men having been employed at the same mine since the beginning of operations 8 and 10 years ago. (*Continued on page* 704)

HANDLING 25 to 50-foot STRIP MINING

A Dodge coupe is shown at the right backed into the 16-yard dipper of the 750-B electric shovel used in the operations of the Pittsburgh & Midway Coal Mining Company's No. 10 plant

Below is another view giving an idea of the size of the largest shovel in the Kansas-Missouri field. The gentlemen in the picture, from left to right, are H. H. Spencer, C. F. Spencer, K. A. Spencer, H. C. Widmer and Chas. H. Williams

In the Kansas-Missouri Field

By K. A. SPENCER *

Easy fast digging with relatively low cost per yard, makes possible removal of excessive number of cubic yards of overburden to ton of coal, which permits profitable recovery of thin seams—Bank machine method of haulage and horizontal type loader used—Great overburden and track cost makes for high cost of operation.

DESCRIPTION OF THE AREA

THE workable coal in the Kansas-Missouri field occurs in an irregular, elliptical shaped-area, extending in northeasterly-southwesterly direction through Cherokee and Crawford Counties, Kans., and extends into the northwestern portions of Barton County, Mo. This limited area is a portion of the Western region described in our U. S. Geological Survey literature. It contains approximately 130,000 acres. The surface of the area is flat, as is typical of Kansas prairie country, with a normal drainage to the west. The stratography of the area is remarkably simple, and may be briefly described by saying that the Pennsylvania formation, the basal member of which is the Cherokee shale, rests unconformably upon the Mississippi lime. The Cherokee shale contains all of the workable coal within the area and it is from this geological name that the Cherokee seam has taken its name. The normal dip of the formation is away from the Ozark up-lift to the south and east of the area. The normal dip being from 20 to 22 ft. per mile down the dip, which is north 68 degrees and 50 minutes west.

Within the Cherokee shales, there are five seams of coal being worked at this time. The principal seam, and by far the most important from an economical standpoint, is the Weir-Pittsburg seam, commonly termed the Cherokee seam. This seam occurs about 240 ft. above the Mississippi line and varies in thickness from 28 to 54 in. The thicker coal being in the southeast portion of the area in the vicinity of Weir and Scammon, Kans. Proceeding up the geological column about 82 ft., there occurs a 14-in. seam, termed the "Prairie" seam, which, at this time, is being mined by steam shovel process. Fifteen to 20 ft. above the Prairie seam, lies what is commonly known as the "22 Inch" or "Mineral" seam. This seam is rapidly becoming more important, in the Kansas-Missouri field, due to the rapidity of which the Cherokee seam is being exhausted and there are at present, three large stripping plants on this seam, with two others under construction. Twelve to 20 ft. above the 22-in. or Mineral seam, occurs the "Pioneer" seam of coal, which is, at this time, being exploited by two strip mines, one equipped with a 150 steam machine, the second with a 320, 10-yard electric Bucyrus. Approximately 90 to 100 ft. above the Pioneer seam occurs the Fort Scott, which is of minor importance, except for local custom trade, as it occurs directly under the Fort Scott lime, which is the base of the

* In charge of Engineering, Pittsburg Midway Coal Mining Company.

The 750-B electric shovel, with 16-yd. bucket, 54-ft. sticks, and 75-ft. boom—gross weight 1,005 tons, mounted on caterpillars

Mammaton formation, or in other words, marks the top of the Cherokee shale. This limestone is a barrier in the stripping of this thin vein and so has made it of little importance.

Recalling the normal dip of the formation, it is obvious that the outcrops of these various seams will be crossed in proceeding northwesterly across the area. The deeper seam encountered first, and the other seams in the order just mentioned. These crop lines running approximately parallel in the northeasterly and southwesterly direction, characteristic of the entire area and at right angles to the Ozark up-lift.

History of Coal Stripping Within the Area

The earliest records of coal production in the Kansas-Missouri field, dates back to 1869, when small deep mines and team pits were opened by the early settlers in the vicinity of Scammon, Kans. Power excavators were not introduced until about 1905, when Mr. Miller, of Mulberry, Kans., put into operation a power excavator, similar in design and construction to the present ditch digger. The dirt was removed from the machine by wagon. A revolving shovel was placed in the field by J. H. Blair, a contractor from Illinois, who installed a ¾-yd. Thew shovel near Midway, Kans,, on property owned by the Pittsburgh & Midway Coal Mining Company. This operation proved unsuccessful and was abandoned after about a year and a half. In 1909, three 1½-yd. Vulcan shovels, built without leveling device, were sold in the Kansas-Missouri field. These shovels were in operation by 1910, and marks the beginning of successful strip mining operation in the field.

It was at one of these plants, operated by J. H. Durkee, near Stippville, Kans., that an argument arose, as to whether the horseback should be removed by the machine. Mr. Durkee's answer to the salesman, who was raising the complaint, was "That which God has joined together, let no man put asunder," and so the horsebacks were loaded and that may account in some small way for the difficulties that have had to be overcome by the strip miner in competition with the deep shafts.

By 1911, larger type Marion and Bucyrus machines were employed, and in 1914, a 225 Bucyrus, 7-yd. machine was put in operation near the old pits, formerly operated by the ¾-yd. Thew. The rapid development of the shovel manufacturers along with the increased knowledge of operating these larger type machines has advanced to the point that at present in the Kansas-Missouri field, there are 56 Marion shovels and 54 Bucyrus machines now in operation, removing overburden from veins of coal, previously mentioned with shovels ranging in size from 1¼-yd. to 16-cu. yd.

It is interesting to note the increasing tonnage produced by the stripping method, for example, in 1918 the annual tonnage for the Kansas-Missouri deep mines was 9,264,000 tons, and 1,036,000 tons from strip mines, or 9.5 percent of the total coal production was produced by the stripping mines. In 1928, we find that 3,003,005 tons of coal were produced from deep mines, and 2,866,846 tons from strip mines, or 48.8 percent of the total from strip mines.

Stripping Methods in the Kansas-Missouri Field

Our methods in the Kansas-Missouri field are in many respects similar to those employed in the Illinois, Indiana and Ohio and Western Kentucky fields. There are two conditions very different from the neighboring fields, characteristic of our Kansas-Missouri field. First, the nature of our overburden is favorable to stripping. We have what we term, easy, fast digging. Very little of our overburden requires bank shooting, or any preparation of the overburden ahead of the stripping unit, and I would estimate that, at present, less than 20 percent of the strip mining in the Kansas-Missouri field requires bank shooting. The second point, characteristic of our field, is the extremely thin vein of coal which is exploited. Mines are now in operation and being operated at a profit, on veins as thin as 12 in. and our thickest seam at present is 3 ft. 6 in. For this latter reason, it is obvious that very careful calculations have to be compiled before large investments are made.

In the Kansas-Missouri field, like many other older fields, the general location of the coal seam is common knowledge. However, in our field, rather accurate drilling is carried on before any development is started. It is common practice to drill the coal leases every 660 ft., and I have observed some leases that have been drilled every 330 ft. After the drilling has been completed, the surface is contoured on the 2-ft. contour interval; this statement alone gives some idea of the flatness of our prairie country, in comparison with other stripping fields. After the contouring has been completed, and the leases are drilled, structural maps of the coal are prepared. The structural and the contour maps are indispensable, in determining the proper method of opening up the lease, and are extremely helpful in the solution of the drainage problem, both of surface water and water on the coal. After this data has been compiled, it is simple to prepare maps, similar in appearance to the contour maps, whereby each line, instead of designating an elevation, designates a definite ratio of cubic yards of overburden to one ton of coal and the area perimetered within the various lines and in the final report of the lease, stating the number of acres. the number of tons that will occur under various definite ratios.

In determining the theoretical tons per acre on the Cherokee seam, it has been found, by experience, that approximately 13 percent of the theoretical tons in place are composed of horsebacks, or faults, and this correction must be made in calculating ratios. It has also been found, that other things being equal, with present stripping equipment and the current price of coal, it is practical and profitable to exploit veins which have overburden in proportion with tons of coal in place to where the ratio does not exceed 15 to 1.

This figure, of course, would fluctuate with changing conditions, both of the physical property and of the market. This matter of handling rather high ratio of overburden to a ton of coal recovering thin veins of coal under rather light overburden compared with other fields, has brought about the demand for a different type stripping unit, and so we find in the field a 350 electric Marion machine, equipped with an 80-ft. boom, and a 12-yd. bucket; a 320 Bucyrus with a 75-ft. boom and 50-ft. sticks and a 10-yd. bucket, and at our No. 10 plant a 750 Bucyrus electric, with an 85-ft. boom, 54-ft. sticks and a 16-cu. yd.

This dipper-full was measured and found to contain 22 yds. of loose dirt. This machine is capable of making a cycle every 42 seconds, and has been moving 8,021 cu. yds. per shift since its installation

bucket. These machines are capable of handling large yardages in overburden not to exceed 35-ft. It is obvious that in stripping with such a high ratio, it is vital that the cost per yard of removing dirt be quite low, and these big capacity machines seem to be the answer.

The method of handling dirt with these machines has also taken on a rather characteristic style, due to the thin vein of coal. These methods depend primarily upon the system of haulage. The method behind the 16-yd. machine is the common practice. This is to have a 42-in. gauge track with 60-lb. rails in the pit. This track is laid behind the shovel in each pit and torn up ahead of the shovel as the shovel advances. However, unlike Illinois and Indiana, the berm required for this track is comparatively narrow, the dirt stands well and there is little bank shooting to cause shattering of rock over the track. This narrow berm has an obvious advantage, in that it materially reduces the angle of the swing of the stripper and so allowing the caterpillars of the shovel to stand within 2 to 3 ft. of the edge of the coal in the abandoned pit, allowing the machine to seldom swing through more than 90 degrees. This increases the time actually employed by digging. It has been found practical in the pursuit of the reduction of angle of swing, to stack the first dirt from the cut in a pilot wall, near the toe of the spoil behind this pilot wall of course takes the natural repose of dirt and just before the shovel moves up, two or three buckets are taken on the inside of the pilot wall, giving it a reclining angle of approximately 3 to 1. The remaining dirt going behind this pilot wall and taking the natural line of repose. This system obviously puts more dirt nearer the shovel, and in our experience, increases our yardage per month.

With a modern shovel, both Marion and Bucyrus design, relatively large yardages are being obtained. We have definite records of our 10-yd. machine moving 308,000 yds. in 68 eight-hour shifts, based on engineers' survey from the bank, by carrying the base line on the surface and running levels on the surface and on the coal and making accurate cross sections every 50 ft. The 16-yd. machine at our No. 10 plant moved in April of this year, 288,720 yds. in 36 shifts, making an average of 8,021 yds. per 9-hour shift. This plant loaded 230-426 tons in 1928, behind one 10-yd. machine, and at the end of April of this year, is 6,000 tons ahead of 330,000-ton schedule for 1929, behind a single 16-yd. machine.

Second common method of haulage in the Kansas-Missouri field is, I believe, confined to this area. It is locally termed the bank machine, or bank haulage system. In this system, there are no tracks in the pit, the track being maintained on the surface near the edge of the high wall. The coal is loaded into skips and hoisted by a derrick, by either of two methods, the most common being a skip with a self dumping bottom, with a capacity equal to that of the pit car. The coal is so hoisted and dumped and while the skip is returned to the pit, the train of cars is moved forward so that the loading point is approximately constant. As the skip is lowered into the pit, it is placed near the loader, to favor that unit, and so reduce the angle of the swing of the loading unit. Second method of bank loading, but less common, is to lift the car bodily, from the track, with a crane and set it in the pit, at a point convenient to the loading unit and after it is loaded, replaced on the track. It is common practice to use two cars from the trip, one being hoisted while the other is being placed in the pit for loading, and this process is repeated until the trip is loaded.

This bank machine method of loading has some very obvious advantages—it eliminates any berm in the pit and so reduces the angle of swing of the stripping unit; it favors the loading unit by reducing its swing to the minimum.

After the pit has been abandoned, it is not necessary to keep it pumped. It is less expensive to construct and maintain a track on the surface than it is to build, tear up and re-lay track in the pit. At no time in the operation of the plant is it possible to have coal uncovered and still not available for loading.

This method of loading being practical only in the prairie country, where the normal surface is relatively level. The conditions of the track, when upon the surface, may limit the size of the pit car, on account of gross weight. This limiting factor may prevent the use of large capacity cars over track built on the surface, which is not a consideration when the track is on the coal.

Loading of coal in the Kansas-Missouri field is somewhat unusual, due to conditions met in loading the thin veins. The Bucyrus Erie Company has developed a horizontal type loader which is generally used in the larger strip mines of the district. For example, a standard 50-B electric shovel is used with the exception, that the boom is built up of structural members and in normal conditions is in a horizontal plane, the bottom channels of the boom provide a track. The machine in operation shoves the bucket out the boom into the coal, which has been broken by black powder, then hoisting the whole boom and swinging with loaded bucket to the pit car, where it is tripped. A 50-B Bucyrus electric is capable of handling a 2¾-yd. bucket and makes approximately a cycle every 28 seconds. This machine is particularly well adapted for removing the horsebacks or faults, which are so common in our Cherokee seam. These horsebacks are dug out and stacked upon the spoil bank side of the pit, and as previously mentioned, compose 13 percent of the vein. In order to favor the loader and produce larger percentages of lump coal, we are using a cutting machine with cutter bar in a vertical plane and the coal vein is cut from top to bottom in a straight line along the edge of the ties of the track pit. This also protects the track and the line cut by the cutting machine can be set with a transit and thus fixing the line of pit tracks and the edge of the new pit, it being a simple matter for the shovel operator to keep his caterpillars at a definite distance from the straight edge. The high wall side of his pit being measured by an instrument which records his swing in degrees, thus assuring straight pits.

It has not been considered practical at any mine in the Kansas-Missouri field to load directly into the railroad cars, in the pit, for two reasons. First that the impurities of the coal could not be removed to a point that it would be satisfactory for a railway fuel, and second, that the track expense per ton would be high if constructing standard gauge railroad track on these thin veins of coal; for these reasons all mines in this field are served by either narrow gauge track or truck haul. The drop bottom cars are fast becoming popular and we are now using cars up to 15 tons of the 8-wheel standard type. The coal being dumped into hoppers of 120-ton capacity, hauling trips of 10 to 12 cars to a train. The hoppers are fitted with reciprocating feeders, (*Continued on page* 706)

DRAINAGE and PUMPING, Windber Field, Berwind-White Coal Mining Company

Central pumping station on synclinal axis reduces pumping 40 percent—8,000 cubic yards mechanically loaded and removed from the mine in establishing drainage system—Power supplied through bore hole—Pumping controlled by automatic equipment.

By E. J. NEWBAKER *

WHILE it may be true that a large percentage of bituminous coal is mined without encountering any difficult or expensive drainage and pumping problems, there are many instances that present interesting studies from the engineering and operating viewpoints. In this category may be placed the problem developed by the mining operations in the northern part of the Windber field of the Berwind-White Coal Mining Company.

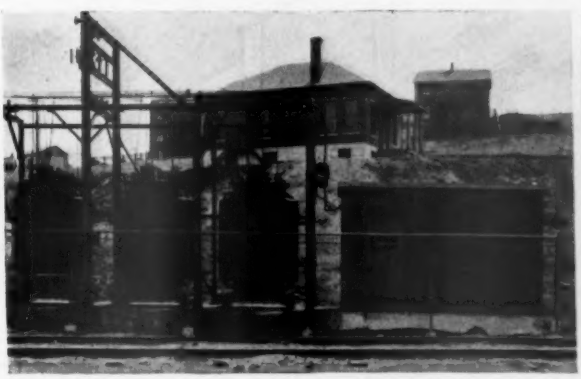
As the mines of this company in the southern part of the Windber field are self-draining, excepting for local basins, they are not discussed here. In the northern part of the field the six mines with development, actual or projected, extend over an area of approximately 26,000 acres, or 40 square miles. Five of these mines are drift mines driven in a general northerly direction toward the sixth mine, Maryland shaft, the latter being 670 ft. deep. The seam operated is the "B," or Lower Kittanning; none of the other seams having been developed or mined to any great extent. All of these mines except No. 37 lie in the Wilmore Basin; a rather broad basin whose axis runs about N. 30° E. with an average dip of 2.5 percent in this direction. The eastern flank of the syncline rises steeply toward the Allegheny escarpment; the western flank rises on a lighter grade toward the Ebensburg anticline. The main heading of No. 37 mine lies very close to the axis of the Ebensburg anticline and has workings on both sides to the dip. The area west of this main heading is easily drained through gravity waterways to the outcrop, or by low head pumping to the surface through boreholes.

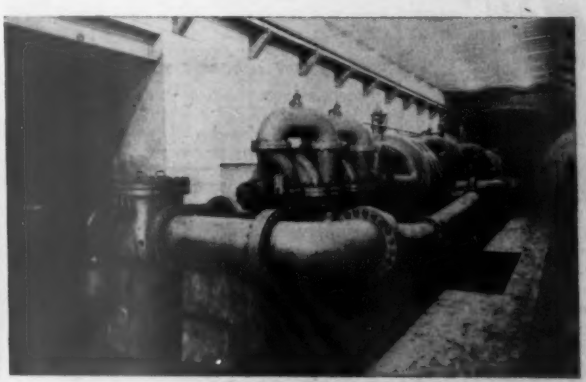
During the early life of the mines, driving to the dip in the Wilmore Basin, water flowed to the outcrop through drainage courses driven on light grades along the flanks of the syncline, and by pumps raising the water to these drainage courses or to the surface. However, as the mines advanced further to the dip, the increasing length of the pipe lines and the number of pumping stages necessary to raise the water to these points, with the increased cost of operation and maintenance, made a new drainage system necessary.

No. 35 mine, with its main heading very close to the synclinal axis and at the center of the five drift operations in the northern field, presented a logical location for a central pumping station. This station was constructed in 1909 and is still operating in an efficient manner. The daily average of water pumped in 1928 was four and one-half million gallons. With the starting of the new system this was reduced about 40 percent. The sump at this station is located directly on the synclinal axis; drainageways rising on both flanks of the syncline lead to it. These drainage courses still intercept most of the water that percolates through the old workings of higher elevation between them and the outcrop; they formerly received water pumped to them by gathering pumps from workings to the dip, although the older outcrop drainage courses continue to take care of the water made above them.

In 1924 the workings of these mines had advanced further to the dip and greater areas had been and would continue to be exhausted, resulting in increased quantities of ground water coming through the broken strata overlying the coal. In addition to this a mine of an adjoining company, higher on the eastern flank of the syncline, had been partly abandoned and flooded. A part of the water of this mine, despite a legal barrier pillar, passes through the broken strata and over the pillar into the workings near the synclinal axis. These conditions rendered the existing pumping and drainage facilities inadequate, and made apparent the necessity for a modern large capacity central pumping plant. The location of an efficient and long-life central pumping plant was not easily decided, and the location of a plant that would take care of these future needs, as far as they could be foreseen, required careful consideration.

* General manager, The Berwind-White Coal Mining Company, Windber, Pa.

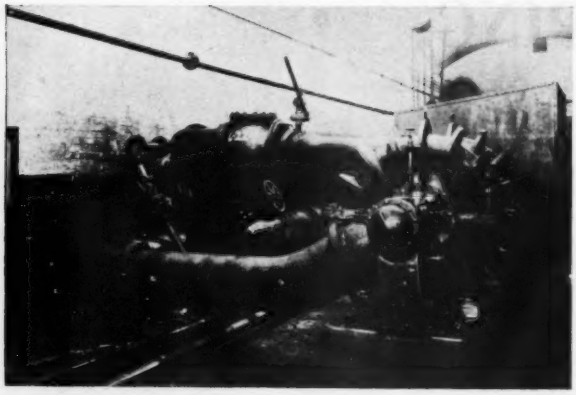




MARYLAND SHAFT CENTRAL PUMPING STATION

Outside transformer station and housing of switches, meters and power bore hole

Looking toward suction well, showing discharge lines, check valve and alleviator



No. 35 Mine Central Pumping Station. Looking toward shaft, showing pump, suction line and discharge line

The logical location was finally decided to be at Maryland shaft, which is close to the synclinal axis and near the bottom of the basin. In fact, the old pumping station used to dewater Maryland shaft workings, except for size and sump capacity, filled all the requirements of the problem. It had the advantage of ready accessibility and proper location to offset the high pumping head. Water from all surrounding workings, present and future, can drain to the sumps by gravity.

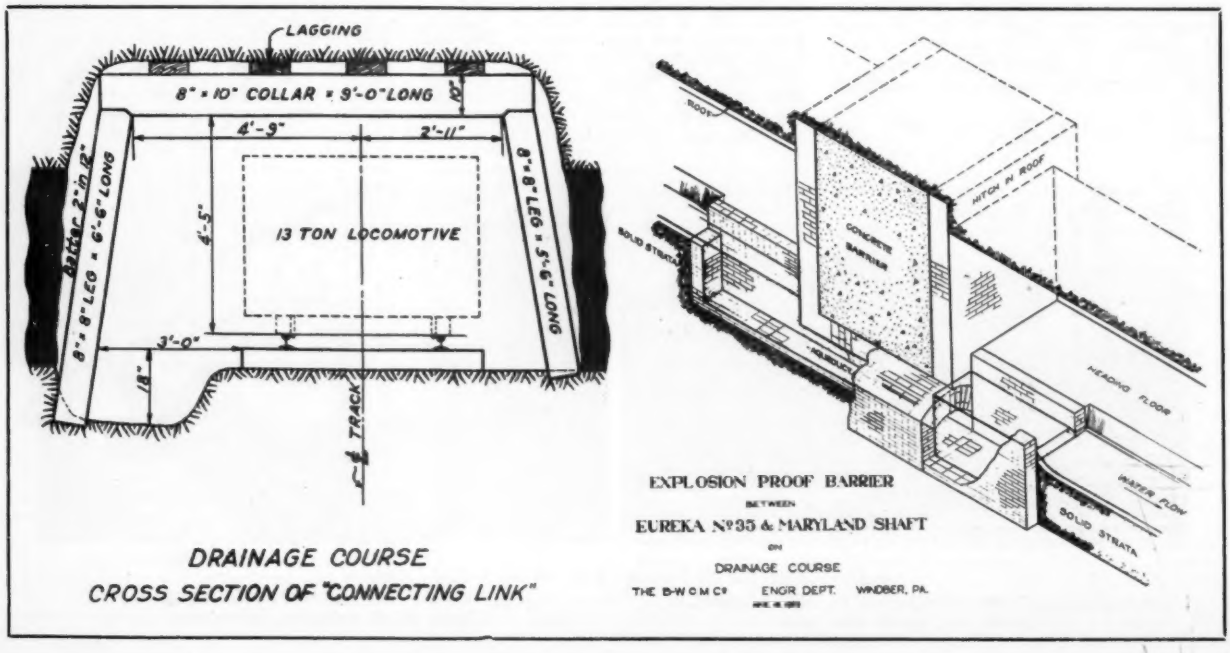
With this in mind it was decided to speed up the advance of a panel entry at Maryland shaft and one at No. 35 mine, and drive a connecting link between the two panels on the axis of the syncline. Work was started in February, 1925, and the connection was made between the two mines in March, 1928. The total distance driven in this time was 9,800 ft.; the connecting link between the two panels being 8,500 ft. long. Provision has been made in the projections of several mines to leave sufficient protecting pillars adjacent to the connecting link and other parts of the drainage course. The "connecting link" is of adequate cross-section and carries a ditch on one side of ample capacity to prevent overflow of track provided for maintenance purposes. During the same time 7,500 ft. of heading at Maryland shaft was driven or reopened and graded to lead the water to the sump.

The strata over the coal along the drainage course average 800 ft. in thickness, the floor of the seam is a fire clay which is rather plastic under the pressure of the overlying strata, and the bottom heaves badly after the coal has been removed. While what appeared to be the best possible alignment for the drainage course was chosen, many local terraces, rises and dips were encountered in the alignment, which required top or bottom rock grading. Irregular contours also necessitated the reopening of 1,300 ft. of an abandoned and caved longwall heading as part of the drainage course. A total of 8,000 cu. yds. of rock were removed in grading, none of which could be stowed in the mines. This work was done economically with two mechanical loaders.

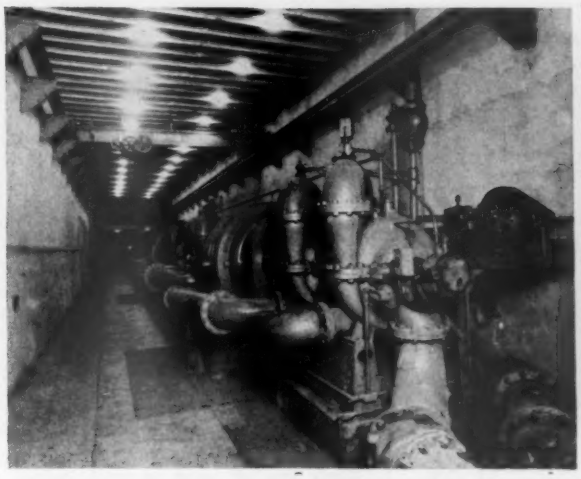
Two features of the drainage course are the settling basins near the main sump, and the explosion-proof barriers, required to separate No. 35 mine from Maryland shaft mine. The settling basins receive the water at a fairly high velocity but slow it down in a relatively large area and the sediment is deposited; practically clear water enters the sump. The basins are built in two parts so that either one can be shut off from the other and cleaned. Brick dams with keyways, for setting logs to act as gates, were constructed at both ends for this purpose.

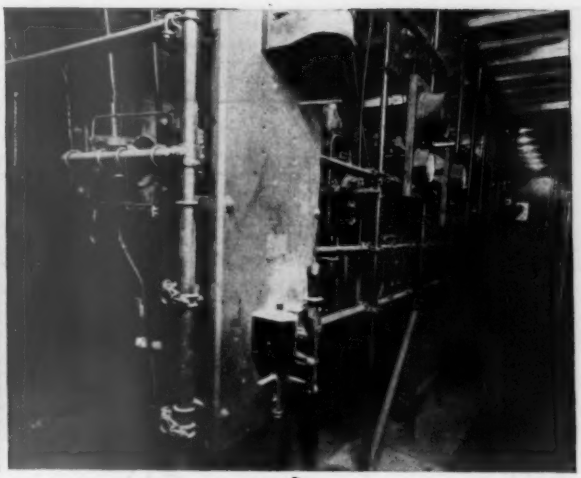
The Pennsylvania Compensation Rating Schedule requires explosion-proof barriers to be built in openings between a gassy mine and a nongassy mine. As the Maryland shaft workings are classed as gassy and the other workings nongassy, it was necessary to construct two of these barriers, one in the drainage course proper and the other in the parallel aircourse. They are 11 and 8 ft. thick, respectively, set into the side, roof, and bottom in deep hitches, and built of brick and cyclopean concrete. Water flows into a trap on the high side of the barrier, through a passage underneath and into a trap chamber on the lower side. When the water fills the trap it acts as a seal, preventing the passage of air from one mine to another. The size of traps and water passages are such that a man can get through them in case of imperative necessity. The drainage course might thus serve as an escapeway in event of a possible disaster.

During the period of drainage course construction, plans were perfected for the sump and pumping station and work started on these. To procure sufficient sump capacity the old sump had to be enlarged and a new sump made. A dip panel heading, which will require about 10 years to exhaust, passes between the new sump and the old sump areas. After the old sump was enlarged and a new one driven, a connection was made between them by driving through the bottom rock under the dip heading on the low water drainage gradient. The sumps were then connected with a water-tight brick and concrete aqueduct built in this rock connection. The opening ends of the two sumps being sealed with brick and concrete dams, which also act as portals for the aqueduct. The aqueduct is 240 ft. long, 4 ft. high, and 3 ft. wide, inside dimensions. When the sumps are



DRAINAGE COURSE
CROSS SECTION OF "CONNECTING LINK"





MARYLAND SHAFT CENTRAL PUMPING STATION

Looking toward Control Room, showing suction end of pump and priming pump

Control Room, showing cables from bore hole to bus bars, panel, etc.

pumped dry the aqueduct is large enough for a man to enter and clean it with a wheelbarrow. The dams at each end of the aqueduct have brick buttresses on the water side. Keyways built in the buttresses will make it easy to build temporary timber and clay dams for confining the water to either sump. The total capacity of the two sumps is estimated to be 5,000,000 gallons.

Work on the pumping station, sumps, and drainage course was so timed that they were completed simultaneously. The entire project was completed the early part of this year and the station is now pumping to the surface approximately 3,500,000 gallons every 24 hours.

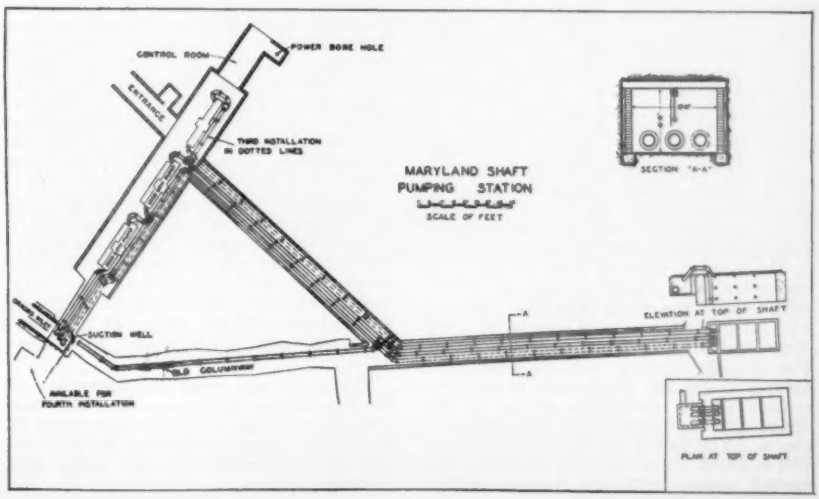
A description of the No. 35 mine central pumping station, constructed in 1909, and the new station at Maryland shaft, is given.

The pump room at No. 35 mine has brick walls and roof and concrete floor. It is 100 ft. long, 20 ft. wide, and 15 ft. high to the springing line of the arch which rises 4 ft. above the springing line. A separate control room, 13 ft. by 13 ft., is built on one side of the pump room. Three-phase, 25-cycle power at 440 volts is supplied by a substation on the surface and power is delivered to the pumps by six cables through a power borehole. The pumping station consists of 3 I. P. Morris two-stage centrifugal pumps, each rated at 4,000 g. p. m. against 330 ft. static head. The pumps are driven by 500 hp. squirrel cage Westinghouse induction motors at a speed of 730 r.p.m.

Two small triplex plunger pumps serve for priming. The priming header connects to all three pumps through valves so that any pump may be primed by opening the proper valve. The suction and discharge lines are 14-in. C. I. pipe, each discharge column has a check valve, and the lines are coupled together through gate valves.

This station is manually operated and runs exclusively on the night shift to reduce the day load on the central power plant.

Details of the construction of the Maryland shaft pump room are shown in the plan and elevation drawings. The concrete-steel pump room is 105 ft. long, 17 ft. 9 in. wide, and 15 ft. 6 in. high; the brick-steel control room at the east side of the pump room is 25 ft. long by 11 ft. wide by 10 ft. high. The west end of the pump room has a brick archway to the suction well. The power and control wiring is in conduit laid in the concrete floor.

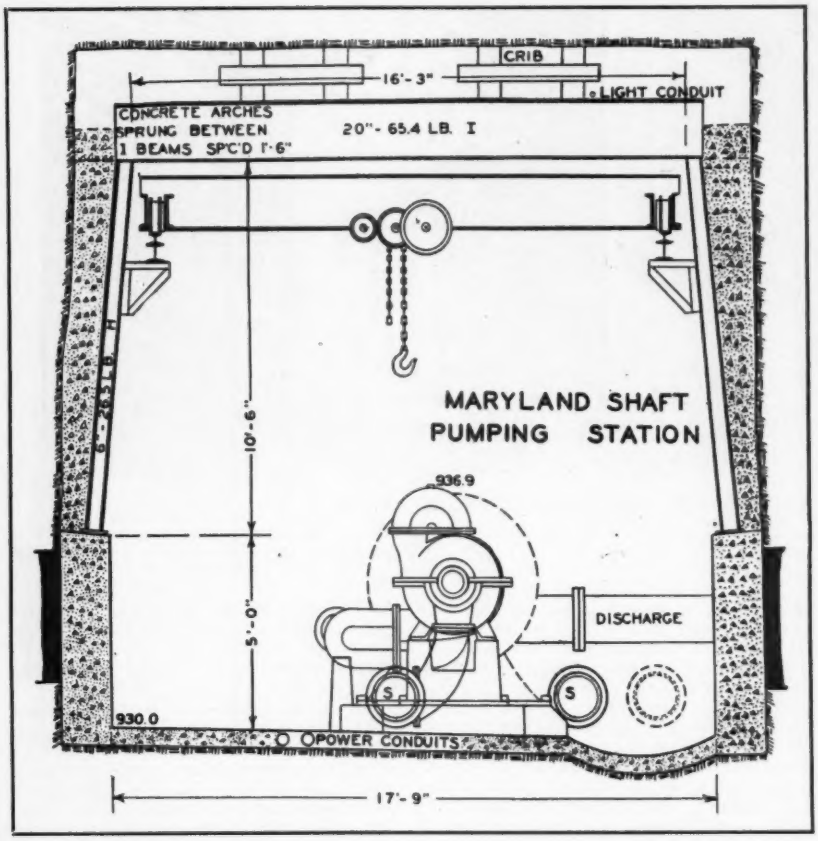


For power supply a 12-in. borehole was drilled from the surface to the top of the coal. The borehole has a 7⅝-in. I. D. standard inserted joint casing; a wooden plug was placed in the first casing pipe, and casing spacers on every other joint. The casing spacers were designed to provide open space in the borehole outside of the casing for four 1-in. conduits to accommodate signal and telephone wires. The casing and conduit pipes were grouted in place with neat cement from bottom to top by sending the grout to the bottom through a 1¼-in. grout pipe. Sections of the grout pipe were withdrawn as the hole filled. This method of grouting assures the entire hole being grouted, as the lower end of the grout pipe is always kept below the level of the rising grout. The strata water was perfectly sealed off in this manner.

An outdoor transformer substation with three 400 kv.a. transformers was built at the power borehole. This transformer substation receives three-phase, 25-cycle power at 13,200 volts and steps it down to 2,200 volts for transmission, down the borehole, through two 3-conductor armor-clad cables. Each cable has sufficient capacity to operate three pumps.

Two Goyne 8-in. 8-stage centrifugal pumps, designed for 2,000 g.p.m. against 705 ft. total delivery head, have thus far been installed. The maximum suction lift is 19 ft. Each pump has four stages on each side of the 525 hp. Allis-Chalmers wound rotor induction motor by which it is driven, Timken roller bearings absorbing any unbalanced thrust. The overall length of each pump and motor is 26 ft. 5 in., each is 5 ft. 9 in. wide and 6 ft. 3 in. high. With the exception of the steel shafts and chrome iron shaft sleeves, the pumping units are made of acid-resisting bronze. The pumps run at 730 r.p.m.

The suction lines are 14-in. C. I. pipe. One of the discharge columns is wood lined, the other cement lined. The wood-lined column was one of the parts of the



old pumping plant utilized in the new layout. The use of cement-lined C. I. pipe of this size is based on favorable results obtained with cement-lined pipe used in the gathering pump system. Both discharge lines are equipped with check valves and are so arranged that either or both lines can be used with either or both pumps. Valves are not used for these interconnections, blank flanges being placed to by-pass the column that is not in service. The plan of the station calls for a third pump and a third column line which will be interconnected with the other two.

Complete automatic priming and control system developed by the Goyne Steam Pump Company and the Westinghouse Electric and Manufacturing Company govern the operation of the pumps. Each pump has an individual 50 cu. ft. per minute priming pump of the dry-air type. The priming pump exhausts the air from the suction line and pump through automatic priming valves, priming header and the float chamber of the balanced valve. Water replacing the exhausted air raises the float which operates an electrical contact starting the main pump. An impulse valve located in the first stage carries an electrical contact which controls the priming pump. When the main pump is brought up to speed this valve opens the contact which stops the priming pump, admits air to the priming header breaking the vacuum in the priming center. The priming pump keeps running and the vacuum is maintained until the main pump attains full speed.

When the vacuum in the priming system is broken, the water drains through a check valve from the float chamber of the balanced valve and the float starts to fall. Attached to the float arm is a plunger, which rests on a diaphragm connected to the first stage of the pump. If the first stage pressure is normal, the diaphragm presses upward against the plunger with just enough force to support the float, but if the pressure is subnormal the float drops, opens its electrical contact and stops the pump. This gives protection against a broken discharge line, or blocked or broken suction line, because the pressure in the first stage of a centrifugal pump reflects instantly any trouble of a hydraulic nature that might result in damage to the pump.

Pumping is started by either a manually operated switch or an automatic float switch. Closing the circuit by either switch sets in motion a motor-driven electrical control drum for each pump. The gears of the control drum can be adjusted so that the drum completes a revolution in 10, 20, or 30 minutes. The control drum immediately sets the priming system in operation and completes its revolution period. If the pump is not operating normally when the drum completes its revolution, the drum stops in the lockout position, stops the priming operation, and energizes an alarm circuit. Or if the pump has been running and trouble of any sort causes the balanced valve to fall and stop the pump, the priming system will function, and failing to get the pump into normal operation in the revolution period of the drum, it will lockout and will ring the alarm. The pump nearest the sump requires about three minutes to prime, the second pump, with its longer suction lines, requires about five minutes. If either pump is not operating within 10 minutes it needs attention; therefore, the control drum has been set for the 10-minute period. Should a bearing overheat, thermostatic relays connected to the control circuit stop the pump and ring the alarm. The alarm bell is located in the engine room of the auxiliary shaft, where an engineer is always on duty. The bell continues to ring until the pump station oil switch at the near-by surface substation is thrown out.

To assure a daily inspection of pumps, the float switch at the sump is arranged to stop the pumps when the sump is drained, but not to start them. Therefore, an attendant must go to the pump room at least once each day to close the float switch. The pumping plant is started in operation late in the afternoon when the peaks of mining operations are off, and stopped before the morning operating peaks are on the central power plant.

Both central pumping stations receive thorough tests and inspections monthly. Speed, discharge pressures, suction heads, water discharge, and power input determinations are made for each pump operating alone and with the other pump or pumps. These will reveal any drop in efficiency or pumping capacity, thus giving warning that repairs are needed.

That this installation of a central pumping station has resulted in definite saving is evidenced by the fact that eight men who had charge of the maintenance and operation of pumps in the old system have been transferred to more productive occupations. Fifty-three pumps have been put out of service, 39 of these being classified as regular station pumps and having capacities varying from 60 to 450 gallons per minute, 14 were classified as gathering pumps and having a capacity of 60 gallons per minute each.

The necessity for gathering pumps for the purpose of lifting water out of local dips has not been done away with entirely, but it can be readily seen that the problem has been considerably simplified.

The column line from these pumps eliminated and recovered amount to 63,000 ft., varying from 2 in. to 10 in. in diameter, but the greater percentages being in the larger sizes.

Considerable expense was eliminated with the discontinuance of these column lines, as rapid incrustation necessitated frequent cleaning. That the elimination of the operation of these pumps and the maintenance of the pipe lines has resulted in actual savings is shown in the pumping cost for the first quarter of 1929 as compared with the cost of the same period of 1928.

Additional saving will result as other feeder drainageways are driven to the main drainage course. While the pumping costs will not continue to decrease indefinitely, they will be less than heretofore, while on the other hand if the new system had not been put in operation, pumping costs would have continually increased.

These savings with consideration of the possibilities for expansion at the new central pumping station to take care of all future requirements has fully justified the investment in the plant and drainage course.

SOME ECONOMIES IN LONGER UNDERGROUND HAULAGE

By NEWELL G. ALFORD*

WITH proper equipment, longer transportation should be cheaper than former short haul—Costs must be reckoned in ton-miles—Track construction, maintenance, size and type of rolling stock, and volume are factors determining cost

LONG mine haulage is not the deciding factor in the successful development of a coal property. Frequently a change of management has greatly improved production costs in spite of increased hauls. In fact, for some years the tendency has been toward increased main haulage, especially in the plants of larger capacity, and there are several outstanding examples where longer transportation is a part of the program for lower production costs.

There is also an interesting relation between longer transportation and the life of a surface plant that has a bearing on the arbitrary classification of developed and undeveloped coal acreage used by the Internal Revenue Department in establishing values of coal as of March 1, 1913. With the taxpayer able to establish that the more remote coal may be economically mined to his present plant, considerably higher value can be set for the base date of valuation on areas that otherwise would be priced by the Revenue Commissioner as undeveloped coal.

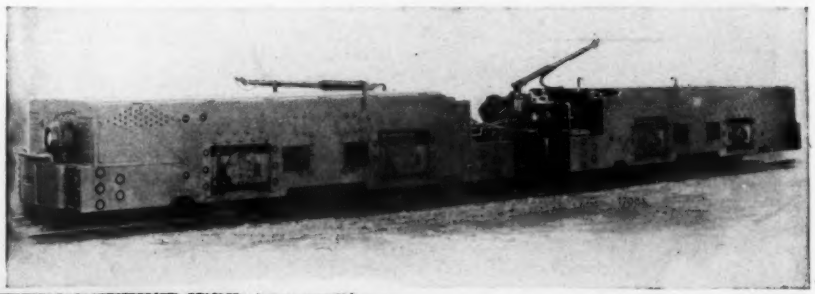
With proper equipment, relatively longer transportation should cost less per ton-mile than on the shorter hauls that once prevailed. Present facilities and

* Consulting Mining Engineer, Pittsburgh, Pa.

Double track main haulage at No. 1-B Mine of the Dominion Coal and Iron Company, at Glace Bay, Nova Scotia. Tracks are laid on 8-ft. centers with 60-lb. rails; 85- and 100-lb. rails are used as crossbars; skin-tight lagging is placed between them. In addition to the uniform side clearance of 2 ft., 11 in., shelter holes are established at 100-ft. intervals.

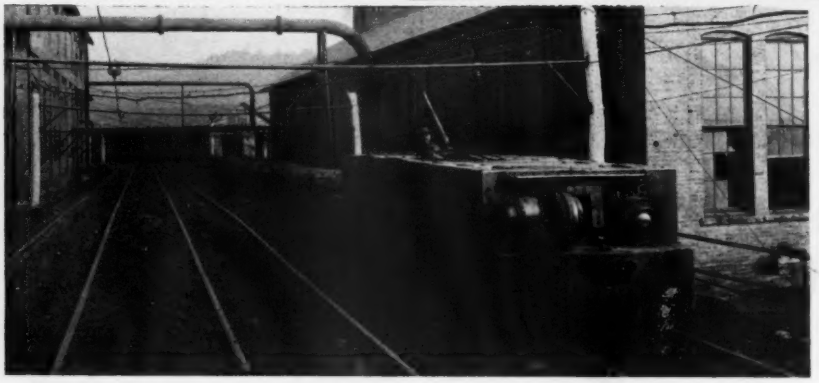
Another view of the main haulage in No. 1-B Mine. Entry section is 6½ ft. by 18 ft. Wall faced with gunite is shown on the left to prevent coal rib from spalling and making dust. The entries are rock dusted with dust from dolomite tailings obtained from a quarry at Point Edwards, near Sydney. Stone dust barriers are used at intervals of 500 ft.

At top of page.—One of two 22½-ton locomotives at the Colver Mine of the Ebensburg Coal Company. It has 3 90-hp. motors and operates on a main haul 12,000 ft. long, with 8,000 ft. of adverse grade averaging 4 percent and as steep as 6 percent in some places. Average gross load is 152 net tons.



Two 20-ton locomotives, for operation in tandem, recently bought by the Consolidation Coal Company for the Mongah Mine in the Fairmont District. They will run at approximately 11 miles per hour. They are designed also for separate operation and were not purchased for maximum capacity but minimum maintenance.

A 30-ton locomotive operating near Windber, Pa. It has 3 motors of 115 hp. each and operates on a speed of about 8 miles per hour.



practice justify the claim that there is practically no limit to which an adequate system of high speed haulage can be carried at a reasonable transportation cost.

Measured in effect, some of the consequences of such installations are:

(1) Prolonged life of plant site and buildings, frequently with a huge saving where surface is valuable.

(2) Where labor is easily supplied from a nearby populous center, even a large investment, with a greater labor turnover, would probably not be a satisfactory substitute at a more remote plant location.

(3) The differential between water and rail shipments to points of consumption may much more than offset long underground hauls; along the Monongahela River, in the Pittsburgh District, areas are classed as river coal that are 10 miles and more from the water front.

(4) In the mountainous districts (and this is a cause rather than a result) stream locations and railroad accessibility often decide the length of mine hauls, especially on large properties.

Comparative estimates for installation and operation, with prevailing local conditions, determine the methods and type of transportation to be adopted.

Vesta Coal Company

The No. 4 Mine of the Vesta Coal Company at California, Pa., is working in the same block of reserves as Mines Nos. 5 and 6. (See *Figure 1.*) The present main hauls at Mines Nos. 4 and 5 are 7 and 4 miles long, respectively. At Mine No. 4 the outby 2 miles is rope haulage, with 2½ miles of outside electric haulage from the pit mouth to the California River Tipple. From the inby end of the rope there is approximately 3 miles of electric haul on flat grades with 30-ton locomotives. These handle 100-car trips of coal on 90-lb. steel rail, with speed ranging from 8 to 9 miles per hour, for an output of approximately 8,000 tons per day.

At Vesta No. 5 Mine, working in the same area, the main haulage is 4 miles long, using the same type of locomotive, but with three 140-hp. motors instead of 90-hp. motors on those machines in No. 4. The additional motor capacity is required by the average grade of 1½ percent against the loads on the main haulage in No. 5. Here the daily output ranges from 6,000 to 8,300 tons.

In Vesta No. 4 Mine the ultimate length of the main haul will be approximately 15 miles. In No. 5 Mine the ultimate main haulage will be 10 miles long.

It is estimated that the average cost of shipping coal on the river from Vestaburg and California to consumption points in Pittsburgh is 22 cents per net ton as compared with an average of $1.01 per ton by rail, from Marianna, Vestaburg and California, which advantage accounts for the increased length of underground hauls on coal accessible from the river.

H. C. Frick Coke Company

The Colonial Dock Plant of the H. C. Frick Coke Company is an interesting instance of long distance underground transportation of coal on belt conveyors. This installation, put in commission in 1924, is on the east shore of the Monongahela River in Fayette County, Pa. (See *Figure 1.*) This system carries the output of the Colonial Mines Nos. 1, 3 and 4 through an underground outlet to the Monongahela River, provided through the purchase of the old Alice Mine from the Pittsburgh Coal Company. This scheme requires carrying coal from each of these mines an average distance of more than 6 miles to the river. A belt conveying system about 4¼ miles long was provided and the coal from these three mines concentrated at one underground dumping point for delivery to the belt conveyor. The location of this dump requires about 2 miles of locomotive haul from underground gathering points.

The coal from all three mines is handled by two rotary dumps, each 370 ft. long, each of which handles an entire trip of 35 mine cars at a time. These dumps are designed to dump 4,000 mine cars a day and they discharge into a bin beneath them. This bin has a capacity of 1,250 tons or about an hour's storage at the rated capacity of the conveying system.

This belt system is divided into 19 individual conveying units of which the largest is 2,439 ft. long, with a net lift of 8.4 ft. The shortest section is 321 ft. long.

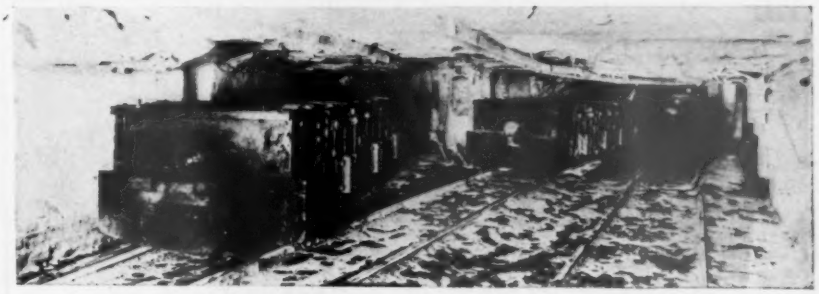
The coal is fed from the bottom of the bin by 34 apron conveyors which all operate together and deliver coal to a belt underneath, 60 in. wide, which runs at a speed of 350 ft. per minute or approximately 3.4 miles per hour. Each of the other 18 conveying units, reaching from the dump to the river, is 48 in. wide, and runs at a speed of 500 ft. per minute, or about 5.6 miles per hour.

This entire system operates on an average grade of 1.5 percent against the load. The greatest lift of any one section is 5.5 percent against the load for a distance of 786 ft. Only one of these units operates on a down grade. This entire system requires 47,000 ft. of belt, equivalent to about 8.9 miles. Since their first operation in April, 1924, these conveyors have handled over 14 million tons of coal. The same company's inland mines at Filbert, Footedale and Buffington, are now consolidated with Lambert, Ralph and Palmer, which last already delivered coal on the river through the Palmer shaft, to supply an additional combined output of 12,500 tons a day at a new river loading plant known as the Palmer dock. This new installation is similar to the Colonial system, and, while the new system has a much larger capacity, it is not as long as the Colonial system. Its total length is 15,398 ft., or about 2.9 miles, with a total lift in this distance of 522 ft., equivalent to 3.4 percent of adverse grade.

At these mines, the main haulage system is actually divided into two sections. The first section transports the loaded mine cars from the gathering point to which they are hauled from the face. From these gathering points in the Palmer mine, the coal will eventually have a total main locomotive haul of more than 4.5 miles in addition to the 2.9 miles of belt transportation that takes it to the dock on the Monongahela River.

At still another of the inland plants of the H. C. Frick Coke Company, the Ronco-Leckrone Mine is an example of a relatively long haul. Here the total underground locomotive haulage is now slightly over 6 miles from the gathering point to the Ronco shaft bottom from where it is hoisted to the tipple.

Based on this company's experience, its management states that with proper



Two 22½-ton locomotives in the Colver Mine of the Ebensburg Coal Company.

25-ton locomotive recently installed at the Dakota Mine of the Bethlehem Mines Corporation, near Fairmont, W. Va. The same frame, with additional weight and larger motors, is used for 30 and 35-ton locomotives.

equipment such as road beds, heavy rail, well constructed mine cars and locomotives designed for hauling long trips of mine cars at high speed, there is practically no limit to which a system of this kind can be carried with reasonable transportation cost. A haulage system of this type, of course, is equipped with signal system, dispatching service and side tracks.

The comparatively long main locomotive haulage lines operated underground by this company have but few accidents and delays in the course of a year, and this is primarily due to the high grade construction, maintenance and inspection not only of road bed and track but of rolling stock as well.

Berwind-White Coal Mining Company

The Berwind-White Coal Mining Company operates its mines Nos. 35, 36, 37, 40 and 42 at Windber, Cambria County, Pa., with comparatively long main haulage. The grades on these main haulways vary from level at Mine No. 37 to an average of 2.4 percent against the load at Mine No. 36. At these plants, the main haulage is done altogether with electric locomotives, for which the maximum adverse grade is 7 percent for a distance of a little over one-half mile. The present total main haulage at these mines ranges from 3.5 to 4 miles. At this group of mines, the eventual length of the total haulage from the working faces to the tipple will be approximately 6.5 miles.

This company began its present method of main haulage in 1915, when it installed a three motored 35-ton electric locomotive, at which time it was the largest electric locomotive in mining service.

As an example of one of the development difficulties which are encountered in a new undertaking of this kind, the locomotive was unable to handle more than 70 mine cars per trip, due to the limited capacity of the motors from overheating. In experimenting, it was found that the motors would carry practically twice as much load when a current of air was blowing through them. The locomotive was then equipped with mechanical ventilation for the motors, and the solution was so successful that the size of the trips was increased to 100 mine cars. The locomotive has since been operating successfully at this rate against comparatively heavy grades.

Recently this company installed a 38-ton locomotive for operation on adverse grades for a haul of 21,650 ft., where the maximum adverse grade is 5.6 percent for a distance of 1,000 ft. While the rated drawbar pull on this locomotive is 9.5 tons at 8 miles per hour, its approximate speed on the average 2.4 percent adverse grade is 9 miles per hour.

Rosedale and Rolling Mill Mines of the Bethlehem Mines Corporation

The Rolling Mill Mine was opened 68 years ago, at the beginning of the Civil War. In that time, it has produced over 20,000,000 tons of coal from what is known as the C Prime Seam; 40,000,000 tons more of coal are allotted for production at this plant through the present haulways. The remaining recoverable coal at this mine covers an area of approximately 10 square miles. From the working faces in this mine, the coal is hauled 5 miles underground to a shaft through which the coal is dumped to a loading pocket in the B seam below it. From the foot of this underground shaft, the coal is hauled through the lower seam for a distance of 2 miles to the Rosedale shaft, where it is hoisted to the surface and cleaned in a washing plant before being carbonized. In this mine, the main haulage system is equipped with dispatching service, signal system and side tracks. The road bed is well graded and surfaced and laid with 70-lb. steel rail. The electric locomotives of 35-ton capacity handle 140 mine cars per trip at a speed of 10 miles per hour. On this 2 miles of haulage the maximum grade of 6 percent for 800 ft. favors the loads. The average grade for the entire 2 miles is 2 percent favoring loads.

Mill Creek Coal & Coke Company

At this company's Tug River Mine, McDowell County, W. Va., mining the No. 3 Pocahontas Seam, the average total haul from the working places to the tipple is 5.7 miles. This mine is fully developed and is now retreating. The coal is all hauled over an outside tramroad 3.6 miles long from the mine opening to the tipple. Since the time that operations began, the average total haul for this mine has been approximately 4.5 miles for the entire coal area developed.

Cosgrove-Meehan Coal Corporation

This company is operating its Panama Mine at Panama, Montgomery and Bond Counties, Ill. This mine is operating in what is known as the No. 6 Seam with a shaft over 500 ft. deep. The physical conditions at this mine as to roof, grades and coal thickness are comparable to those usually encountered in southern Illinois and western Kentucky. To date the mine has worked out approximately 1,700 acres of its original boundary and

Tabulation of Approximate Total and Ultimate Hauls

Mine	Miles		
	Present Car Haul	Approx. Total Haul	Approx. Ultimate Haul
Banning No. 1	....	3.50	.....
Banning No. 2	3.50	4.75	.....
Warden	....	4.70	.....
Ocean No. 5	3.30	4.46	.....
Vesta No. 4	....	7.00	15.00
Vesta No. 5	....	4.00	10.00
Colonial Dock	2.00	6.50	.....
Palmer Dock	4.50	7.40	8.75
Ronco	....	6.00	.....
Colver-Ebenburg Coal Company	....	2.20	.....
Berwind-Windber	....	4.00	6.50
Rolling Mill-Rosedale	5.00	7.00	.....
Mill Creek, W. Va	....	5.70	.....
No. 1-B, Glace Bay, N. S	....	2.50	.....
Figure 1—Western Kentucky	....	1.50	4.80

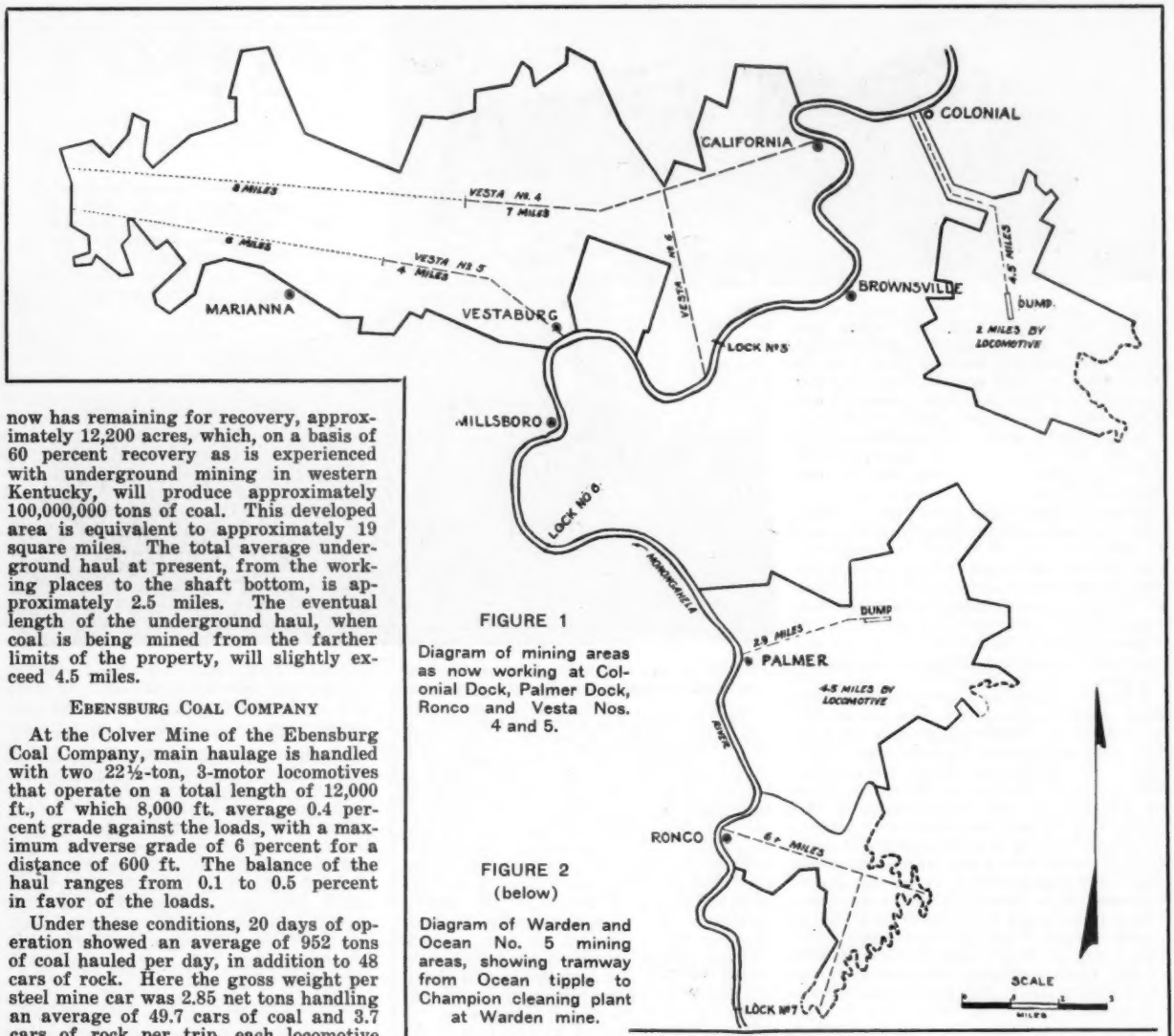
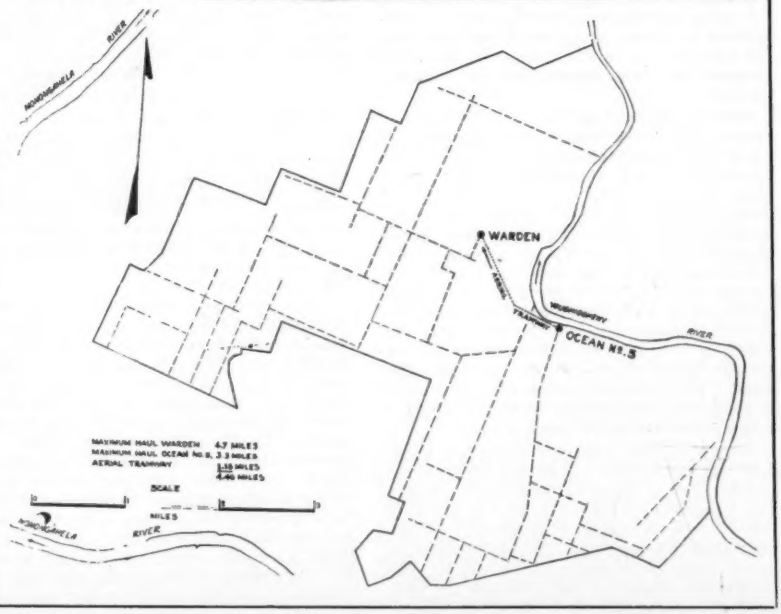


FIGURE 1

Diagram of mining areas as now working at Colonial Dock, Palmer Dock, Ronco and Vesta Nos. 4 and 5.

FIGURE 2
(below)

Diagram of Warden and Ocean No. 5 mining areas, showing tramway from Ocean tipple to Champion cleaning plant at Warden mine.



now has remaining for recovery, approximately 12,200 acres, which, on a basis of 60 percent recovery as is experienced with underground mining in western Kentucky, will produce approximately 100,000,000 tons of coal. This developed area is equivalent to approximately 19 square miles. The total average underground haul at present, from the working places to the shaft bottom, is approximately 2.5 miles. The eventual length of the underground haul, when coal is being mined from the farther limits of the property, will slightly exceed 4.5 miles.

Ebensburg Coal Company

At the Colver Mine of the Ebensburg Coal Company, main haulage is handled with two 22½-ton, 3-motor locomotives that operate on a total length of 12,000 ft., of which 8,000 ft. average 0.4 percent grade against the loads, with a maximum adverse grade of 6 percent for a distance of 600 ft. The balance of the haul ranges from 0.1 to 0.5 percent in favor of the loads.

Under these conditions, 20 days of operation showed an average of 952 tons of coal hauled per day, in addition to 48 cars of rock. Here the gross weight per steel mine car was 2.85 net tons handling an average of 49.7 cars of coal and 3.7 cars of rock per trip, each locomotive making an average of 12.9 trips per day; 70-lb. steel rail is used in the dip section.

Dominion Coal Company, Nova Scotia

At the No. 1-B Mine of the Dominion Coal Company in Nova Scotia, 16-ton locomotives on a 36-in. track gauge haul from 50 to 75 car trips with an average haul of 2 miles, and a maximum main haul of 2.5 miles, with an average grade of 0.3 percent favoring loads, and a maximum grade on 900 ft. of 1.5 percent against the loads. Sixty-lb. rails are used on the main road, which is carefully inspected and maintained in first-class condition. With the exception of 3,000 ft. the entire length of this haul is double track; while three 16-ton locomotives are used in this service, there is a wide margin of capacity. The normal output ranges from 2,800 to 3,000 gross tons per eight-hour shift. Here the limiting factor is the hoisting shaft rather than locomotive capacity.

Pittsburgh Coal Company

The Pittsburgh Coal Company at its Champion No. 4 coal washing plant at the Warden Mine, receives coal from

FIGURE 3

Diagram of Banning Nos. 1 and 2 mining areas, showing tramway from tipple No. 2 to Champion cleaning plant at Banning No. 1.

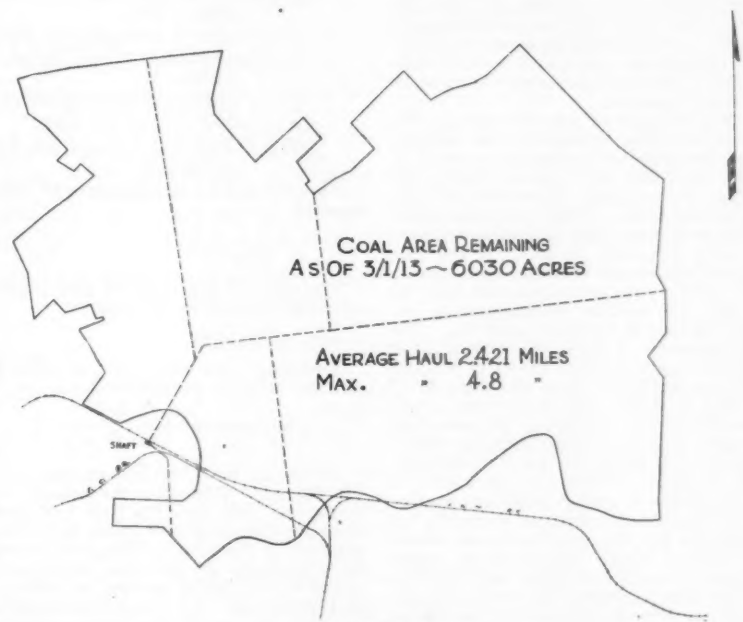


FIGURE 4

NO. 9 AND NO. 11 SEAMS, WESTERN KENTUCKY.

Western Kentucky mine with shaft for working 6,000 acres of coal in each of two seams with the ultimate haul of 4.8 miles.

Ocean Mine over about 1¼ miles of aerial tram. (See *Figure 2.*) In addition to this, there are 3.3 miles of main haulage in the Ocean Mine from the gathering point to the tipple, where coal is delivered to the aerial tram. The main haulage in the Warden Mine is close to 4.7 miles. At its Champion No. 5 washing plant, near Banning, Pa., this company transports coal from Banning No. 2 by aerial tram to the washer. (See *Figure 3.*) The main haulways in the Banning Nos. 1 and 2 Mines are about 3 and 4 miles long, respectively. The tramways each have an hourly capacity of 125 tons.

Western Kentucky

Figure 4 shows a boundary in western Kentucky, underlaid with workable areas of both the No. 9 and No. 11 seams, and containing approximately 6,330 acres of original coal area in each of them. The shaft, as shown to the No. 11 seam, is approximately 80 ft. deep and the No. 9 seam is about 90 ft. below it. The map shows the area mined out of the No. 11 seam up to March 1, 1913. The Government at first conceded only 2,000 acres of the remaining coal in the No. 11 seam as being developed, although the surface plant is substantial enough to serve for mining the entire area, with underground conditions that are perhaps the most favorable of any in that field. A large part of the labor is supplied from a nearby town, with an approximate population of 4,000, so that the housing requirements at this plant were not extensive. In keeping with the company's past policy, the present plant and shaft will actually be used to mine the entire area shown in both seams, with the possibility of additional acreage being added in the future.

An old mine in the same district, which has operated successfully, has mined 2,100 acres of coal with a maximum haul of 3.5 miles, with grades that are not nearly so favorable as in the property shown. Because of favorable mining conditions, and the fact that the same shaft can be used for the development of the lower seam, this plant location will carry an average underground haul of 2.4 miles for the entire area, the maximum haul being 4.8 miles. Underground installation has been substantial enough in character to justify its extension over an indefinite period, and in presenting this claim the mining company cited many instances where much longer hauls are used with underground conditions considerably more adverse than on this property.

Another operating company in the Central Pennsylvania Field, with an output of 2,500 tons per day, has reconstructed its main heading for high speed and efficient main line haulage, and will be able to extend the life of the property by 25 years with a total expenditure that is approximately 3½ percent of the cost of opening up the additional developed territory as a new mine.

On trolley haulage of from 8 to 10 miles per hour for locomotives larger than 20 tons, the rails range from 60 to 90 lbs. in weight, and some mining companies are now installing 6/0 trolley wires.

In some cases additional capacity is secured by operating 15-ton locomotives in tandem.

In a study of costs for relatively long haulage, it is necessary that any comparisons be expressed in expense per ton-mile, and with due allowance for variation in grades, such actual figures as are available show that the cost will range from about 2 cents on better conditions to about 14 cents per ton-mile, without gathering, for adverse conditions. These figures include all installation and operation charges, with interest and depreciation. Factors also affecting these costs are varying degrees in character of track construction, maintenance and size and type of rolling stock, as well as the volume of coal handled. If a proposed installation is planned with these items in mind, the cost per ton-mile should be no greater for the last mile than for the first mile of the total distance, if the tonnage is sufficiently large.

POWER PROBLEMS
in Relation to Bituminous Production

Suggestions for use of coal operators to give clearer understanding of proper use and application of power—Formula for load distribution—Power requirements affected by a number of factors—Cleanliness and care of equipment has great influenc on economical operation of equipment and amount of power consumed

By R. M. WATT *

HAVE noticed a singular significance in the program which has been arranged for this convention. It contains approximately 40 subjects, among which are such topics as "Cleaning Coal," "Mining Methods," "Conveyors," "Mechanical Loaders," "Safety," etc., and so on; yet the subjects of "Power" and "Labor" seem to be the only ones which present themselves to the program committee as a problem. My knowledge of some mines would lead me to believe that this designation could be more appropriately attached to the subject "Cleaning Coal." It may be, however, that the power subject has appeared to the program committee and probably to a good many operators as a "mental hazard," and as such appears to be more of a problem than it actually is. The engineers who are connected with the mining industry, I am sure, will agree with me in that the application of power to the mining of coal is the most flexible commodity in use in the industry and offers itself as a means of bringing about a solution of a great majority of the many other perplexing problems with which the industry is confronted.

The mine power business of today is the result of a pioneer effort on the part of those connected with the mine industry in the early days. Not until a very few years ago did the central power station enter upon the scene. Its appearance was the demand of the coal industry for a more abundant supply in a more consistent form. As the industry increased its use of mechanical equipment the requirements of central station power naturally increased. Eventually the public utility operators realized the potential possibilities of this business and came in to lend a hand for its further development and application. A survey of the present-day situation discloses the fact that practically all, or at least a very great majority of, the coal mined receives its power supply from central stations operated either by the mining industry or the utility industry. Inasmuch, therefore, as the mine operator was the pioneer in the application of mechanical power to the production of coal, he should not approach its problems with a "mental hazard" attitude, if such really is the case.

It is my effort in this paper to suggest, in a simple manner, some of the things which may aid the average coal-mine operator to understand more clearly the proper application of electric power to the production of coal. I am not making use of technical data, except in one case which seems necessary to convey the point properly, nor am I resorting to numerous sources of statistics which the engineers of the industry have compiled. The suggestions which I may offer are applicable to any source of supply, whether it be purchased from transmission systems or generated by an individual or central power station owned by the mine operator.

The consumer of electric energy for power purposes, whether it be mining, manufacturing, or any other industry, is concerned foremost with the source of supply; its capacity, dependability, and voltage regulation. The diversity factor of the coal-mine load is ordinarily very low and, it might be said, in the majority of cases very variable, from day to day. The normal requirements may be 500 hp., yet certain conditions may demand the use at times of 1,000 hp. The total capacity of the equipment utilized in a mining operation is, as a general rule, two or three times the amount of capacity in active use at any one time; nevertheless it is necessary to make this provision in order to facilitate the movement of coal from the mine to the car. Such conditions make it necessary to have a source of supply sufficient to provide, whenever the occasion demands, an abundance for the most extreme cases. The limited supply brings about losses by delays occasioned by power failures and by slowing down of equipment in operation. The design of electrical equipment provides for satisfactory operation over a variation of voltages 10 to 15 percent above or below normal. Unless such conditions are maintained with reference to voltage regulation the best results, of course, will not be obtained. Proper regulation of voltage to the various points of consumption over a mining operation can only be obtained by proper arrangement of the distribution system. In this arrangement due consideration must be given to the location of conversion equipment so as to minimize the distribution distances of low-voltage energy. The most efficient arrangement is that which balances the distribution investment charges with the distribution line loss charges. Inasmuch as voltage regulation and distribution line losses play such an important part in the production costs of coal, affecting labor, equipment, and power cost, I am offering a formula which may be useful in arriving at the economic size of conductor for a specified load:

Let I=Amperes flowing in conductor.
h=Hours of operation per year.
p=Ohms per circular mil foot—10.37 at 20 degrees C.
c=Cross section area in circular mils.
L=Length of conductor in feet.
x=Cost of copper per pound, in dollars.
y=% interest and depreciation.
z=Cost of energy per kwh.
W=Weight per circular mil foot, in pounds.

The cost of energy loss per year in line equals:

$$(1)\quad \frac{I\ p\ L\ h\ z}{1000\ c}$$

The cost of depreciation and interest on investment in metal equals:

$$(2)\quad \frac{c\ W\ L\ xy}{}$$

Equating: (1) and (2) and solve for circular mils per ampere of load.

$$\frac{C}{I} = \text{Sq. root of } \frac{p\ h\ z}{1000\ W\ x\ y}$$

(It should be noted that economic conditions *alone* determine the size of conductor by this formula and the ohmic drop per unit length of conductor is independent of the actual voltage or current to be carried. It therefore bears no relation to the actual amount of power to be transmitted. An investigation should be made to see if the drop calculated from economic conditions is suitable for the load under consideration.)

To show the value of considering the economic cross section of a conductor which is to carry a specified number of amperes so many hours per year, let us take the following problem:

Load—Kw. 100.
Amp. 400.
Volt 250.
Days per year, 300.
Hours per year, 3,000.
Cost of copper, $0.18 per pound.
Interest plus depreciation, 10 percent capital investment.
Cost of energy, $0.015 per kwh.
Distance load from supply, 1,000 ft.

Using the above data, we arrive at the following calculated values:

* Kentucky Utilities Co., Pineville, Ky.

Area in cir. mils.	Cost of copper in $	Annual cost copper in $	Annual cost I R loss, $	Total cost in $	Current flowing in amps.	Resistance of 2 L in ohms	I R drop in volts
200,000	218.16	21.81	748.00	769.80	400	.1037	41.48
500,000	545.00	54.50	298.50	353.00	400	.0415	16.6
1,172,000	1,280.00	128.00	127.00	255.00	400	.01767	7.06
2,000,000	2,180.00	218.00	74.80	292.80	400	.01037	4.148
3,000,000	3,272.49	327.24	49.68	373.92	400	.0069	2.76

In the problem just investigated the hours are rather long for such a load; however, it brings out the point of economic balance. For heavy loads of short duration and light loads of long duration, the root mean squares should be taken; but in this case it would only complicate the problem and tend to cover up the point that it is attempted to bring out. However, an example can be given at this point.

4 hrs. per day at 400 amps.
6 hrs. per day at 100 amps.
300 days per year.

1,200 hrs per year at 400 amps.
1,800 hrs. per year at 100 amps.

The root mean square is the square root of the average square; i. e.:

$$I = \text{Sq. root of } \frac{(400)\text{ sq. } 1{,}200 + (100)\text{ sq. } 1{,}800}{1{,}200 + 1{,}800}$$

I=265 amps.
h=1,200+1,800=300 hours.

A smaller conductor can be used in this case. (Refer to *figure 1.*)

A little study of the equation for economic cross section will show that the distance does not enter since it cancelled out. The formula boils down to a constant times the square root of the hours used.

The equation for circular mils per amp. using the given values for cost of copper depreciation, etc.:

$$\frac{c}{I} = \text{sq. root} \frac{P\ Z}{1{,}000\ Wxy} \times \text{sq. root of h.}$$

$$\frac{c}{I} = \text{constant} = 53.4 \times \text{sq. root of h.}$$

It is evident that the circular mils per amp. is directly proportional to the square root of the number of hours. The economic size of conductor thus will vary with each instance. (*Figure 2.*) "Circular Mils Per Ampere—Versus—Hours Per Year," will show the relation.

A working schedule based on load conditions is a matter of considerable importance in cases where power is purchased on a demand basis, and in cases where the power supply is obtained from a limited source. The highest practical load factor should be maintained in order to minimize the capacity of generating or conversion equipment and capacity of distribution circuits necessary. The circumstances of the operation governs this point entirely. No particular rule will cover a number of mines. It is, therefore, a matter for the management to work out in connection with his own particular conditions. The best solution is an arrangement which will give you the lowest labor cost and the lowest power cost simultaneously. Certainly nothing will be accomplished by an arrangement which will reduce the power cost per ton, and by so doing increase the labor cost per ton in excess of power cost reductions. In quite a few operations the method of mining is to concentrate the mining work over a period of 8 to 10 hours. An analysis of some of these operations may show an advantage to distribute the work over two shifts rather than concentrate it into one. Such is particularly the case when your source of supply is purchased from transmission systems on the demand basis of measurement. There is, however, a tendency on the part of a great many operations to concentrate on the reduction of the power demand and in so doing increase other costs by an amount more than they save in their effort. It is customary to make comparisons between the cost of various mines. Such comparisons are of no value unless the mining conditions are exactly identical. The power cost per ton of coal mined depends on quite a number of conditions which are entirely local, the distance of coal from the drift mouth, the thickness of the seam, the amount of foreign matter to be handled per ton of coal mined, ventilating conditions, haulage grades, cutting conditions, and so on and so forth, none of which are identical in different mines. This, therefore, resolves itself into an individual problem for each mine management to solve for his own particular conditions. The method used by some operators, and which has proven very effective and satisfactory, is to arrange their haulage load and cutting-machine load over a spread of time so that they will not conflict. This arrangement, however, is not in all cases the most economical. For example, when haulage is conducted in one shift and cutting in another it requires the operating of ventilating equipment over a double period of time.

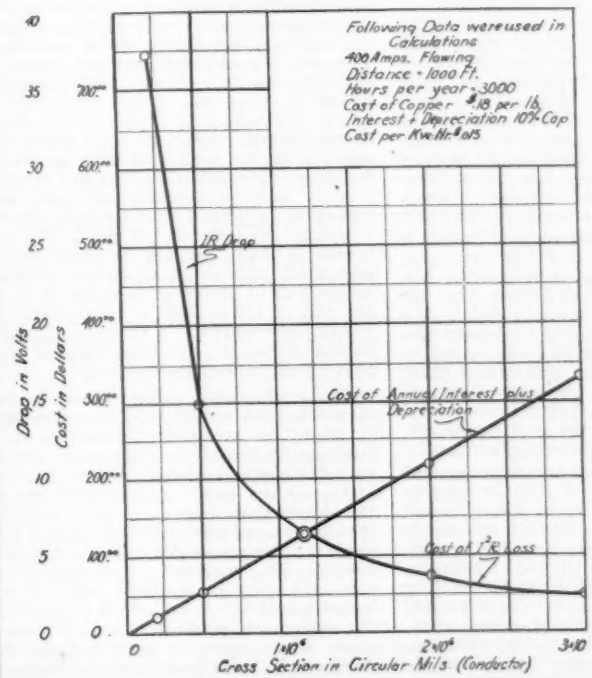

Following Data were used in Calculations
400 Amps. Flowing
Distance = 1000 Ft.
Hours per year = 3000
Cost of Copper - .18 per lb.
Interest + Depreciation 10% Cap
Cost per Kw-Hr. - .015
I R Drop
Cost of Annual Interest plus Depreciation
Cost of I²R Loss
Drop in Volts
Cost in Dollars
Cross Section in Circular Mils. (Conductor)

Figure 1

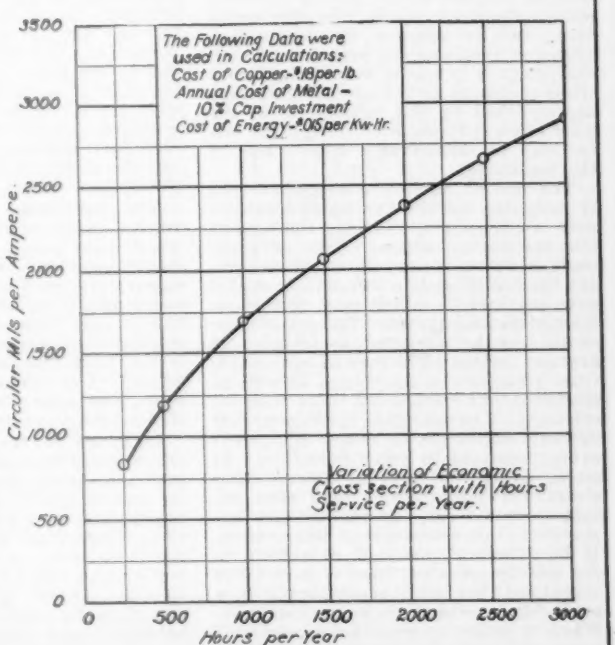

The Following Data were used in Calculations:
Cost of Copper - .18 per lb.
Annual Cost of Metal - 10% Cap. Investment
Cost of Energy - .015 per Kw-Hr.
Variation of Economic Cross Section with Hours Service per Year.
Circular Mils per Ampere.
Hours per Year

Figure 2

In cases where ventilation has to be maintained 24 hours per day this method seems most practical. Power used for ventilation, pumping, store and camp service may be classed as fixed or non-variable, while that used for haulage, cutting, loaders, tipple, etc., is variable and dependent upon amount of tonnage mined. If the fixed load is necessary for the full 24-hour day, then the variable load should be spread over that time in such a way as to gain the most economical operation with both labor and power taken into consideration.

The type of equipment, along with its care and maintenance, is a factor to be given careful and constant consideration. Inasmuch as the production of coal requires the use of conversion equipment in the majority of cases, then that equipment having the least loss in performing its duties is, of course, the logical type to employ. In the greater percentage of cases I believe the synchronous type of rotary converter is the most economically applicable. The synchronous motor generator set, on the other hand, while having a lower conversion efficiency, has its advantage in maintaining better power factor conditions where a highly inductive load is used in addition to the direct-current equipment. I have in mind particularly the shaft mine operations which use large induction motors for operating hoists, and instances where the inductive load used is greater than the d.-c. load to such an extent that the synchronous rotary converter will not sufficiently compensate for power factor. Such equipment that will aid in maintaining a power factor near unity and which will operate with the least disturbance to voltage regulation should be employed. Too little attention is given to the inefficiency of machines, especially when its operating condition is apparently good. A great many mines are using equipment which was designed 15 or 20 years ago. An investigation will probably disclose the fact that the replacement with new equipment of present-day design would well be justified by the saving in power consumption. A poorly designed ventilating fan, for example, is a continuous source of loss, and the first cost of such equipment is in reality very insignificant when compared to the operating savings accomplished by the installation of the most efficient types, even though the latter may be considerably more costly in the beginning.

The use of automatic equipment for reenergizing circuits has added considerably to efficiency by reducing the time of idleness during outages. This arrangement, however, is not fully effective without the use of section switches to segregate any trouble which may develop on the distribution system. The entire mine should not be subjected to troubles of any one section. The care of equipment, from a mechanical standpoint as well as electrical, has quite a bit to do with its efficiency. The mining of bituminous coal presents handicaps to rotary equipment not experienced in other industries. It seems to be the general opinion that cleanliness in connection with mine operation is not only impractical but impossible. I do not concur in this opinion. It is, of course, more of a problem in the mining operation than it is in other operations, but good housekeeping is a profitable investment in every operation. When I refer to good housekeeping I mean not only cleanliness with respect to mechanical equipment but I include the entire premises, electric distribution system, haulage ways, air ways, and even the mining town itself. The haulage track, for example, is commonly used as the return circuit for your electric distribution system. The energy must complete its circuit through the rolling stock. A track, therefore, covered with slate and coal will not offer the same contact as a clean track and will retard the movement of coal. The continuous accumulation of coal-dust particles on the winding of motors eventually work through the insulation, causing costly burnouts. The bearings, too, get their share, and the more they get the more power input is required to accomplish the work for which the motor was originally designed. I am even bold enough to state that poor housekeeping has cost a number of mines 2 kw.h. where 1 kw.h. should be sufficient to perform the work.

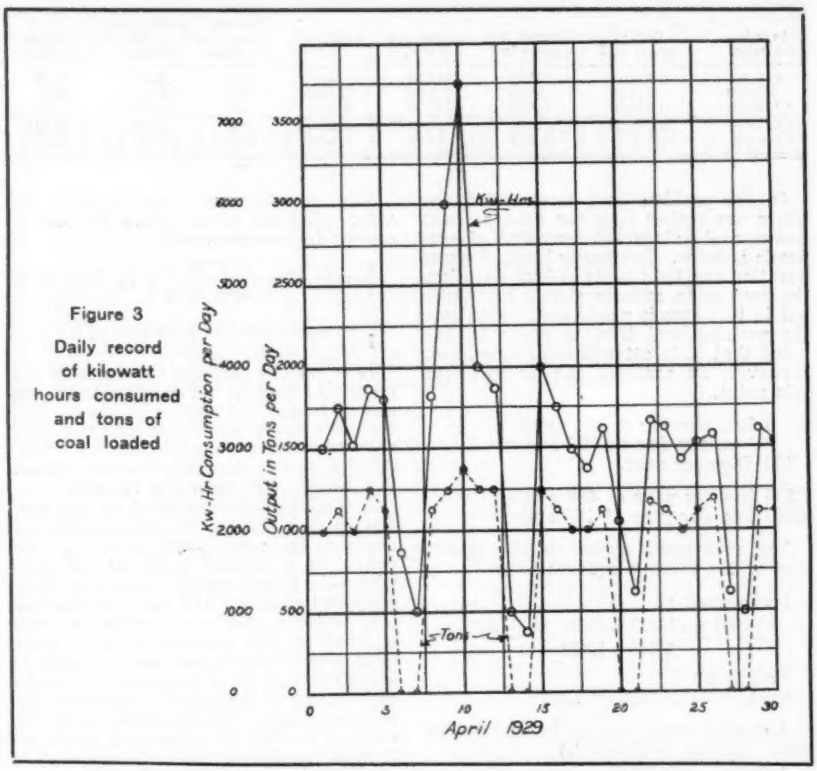


Figure 3

Daily record of kilowatt hours consumed and tons of coal loaded

The coal-mining industry of today is marketing its product among industries which have made rapid strides in efficiency. One ton of coal now does the same work as 2 or even 5 did a few years ago. One of your customers has this to say: "Our use of fuel is already so efficient in our later plants that there is not much margin for a net improvement." The mining industry can, and must, keep closer to the lead in the efficiency race of present-day industries.

Inasmuch as the commodity "power" offers itself in such a flexible manner and is so easily accounted for, it would be well to know the amount of energy required in each phase of coal production. Energy for ventilation, for tipple, for camp and store lighting, for hauling and cutting can be easily measured and recorded, so that in case of unusual consumption the cause of that increase can be traced and corrected before it can reach a great amount. Little thought is given to the amount of energy used in and around the mining camp. This is a good percentage of the total and should be properly accounted for, and any revenues therefrom should be credited to the cost per ton of coal. It is the opinion of some mine managers that the cutting and hauling and loading of coal is the principal consumer of power. On the contrary, the stationary equipment is, as a general rule, the majority consumer. A record from month to month of the amount of power consumed for ventilation, for hauling and cutting, tipple, camp consumption, etc., would be an excellent means of bringing about a better ratio between power supplied and power utilized. A curve plotted with this information, using normal conditions as a basis for any particular mine, will be a source of valuable information, in that any irregularities can be detected at once and remedied. *Figure 3* shows a daily record of kw.h. -v- tons coal mined. The increase of kw.h. per ton indicates an irregularity which can be located without waiting until attention is called to it at the end of the month by an increase in power consumption. A scarcity of information along this line has resulted in a heavy and unnecessary expense.

The coal-mining power business has grown to such an enormous amount that it might be truthfully classified as a business distinct from commercial power or industrial power and lighting. It has attracted the public utility interests to the extent that they have spent millions of dollars to advance its development and make it more applicable to the mining industry. The improper use of energy results not only in a direct cost but an indirect cost by virtue of its damage to the equipment operated. The latter, in a great many cases, is greater than the former. It, therefore, behooves the promoters of this industry to encourage the proper application and thereby increase its usefulness. (*Continued on page* 694)

POWER

at the United States Fuel Company

Human and mechanized labor compared in cost — Sectionalized distribution advisable — Mechanization depends upon reliable power— Regenerative braking motor increases rope life—Mass mechanical production means lower costs and concentrated operations

By L. D. ANDERSON *

WHEN scrutinizing the periodical cost sheets of coal mining for possible means of saving, the cost of power sometimes appears as a disturbing element. If the cost of the power per unit be high or if it be used inefficiently or needlessly, then there is reason for disquietude. On the other hand, there is not always a full realization of the fact that power is the cheapest laborer that can be hired in coal mining. To get this viewpoint it is worth while quoting the words of Harrington Emerson:

"In China men are paid $0.01 per hour for climbing treadmills actuating stern wheels which propel river boats. These coolies convert their stored human muscular energy into mechanical foot-pounds. From experience with treadmills in British prisons we know exactly the mechanical equivalent of hard labor. It is a climb of 8,640 ft. each 24 hours. This is the limit of human endurance for a succession of days. To convert this into horsepower we must know the man's weight and the number of hours he works each day. The average weight of man is about 150 lbs. A man of this weight climbing 8,640 ft. in 24 hours yields 1,296,000 ft.-lbs. A horsepower for 24 hours is 47,520,000 ft.-lbs. It would, therefore, take 36.6 Chinamen to yield a continuous horsepower, and the wages of these Chinamen would amount to $3.66 per day, or $1,336 a year."

Or it may be put in another way. Assume that power costs the abnormally high figure of 5 cents per kw.h. The cost of 1 horsepower for one day would then be .05 x .746 x 24, equal to $.895, or less than one-fourth of the cost of the cheapest labor in the world. By keeping this constantly in mind one gets a new conception of the possibilities of increasing human production and thereby human well-being and happiness through the intelligent use of power.

The mines of the United States Fuel Company, located in Carbon County, Utah, comprise the Panther mine, near Helper, and a group of three mines: Kingmine No. 1, Kingmine No. 2, and Hiawatha, a few miles apart but operating on the same coal measures. Of these three, Hiawatha is at present held in reserve and mining concentrated in the first two. All four mines are supplied with power by the public utility corporation operating over most of the state. As the Panther mine is relatively small and independent of the others, the discussion will be limited to the group of three mines near the town of Hiawatha.

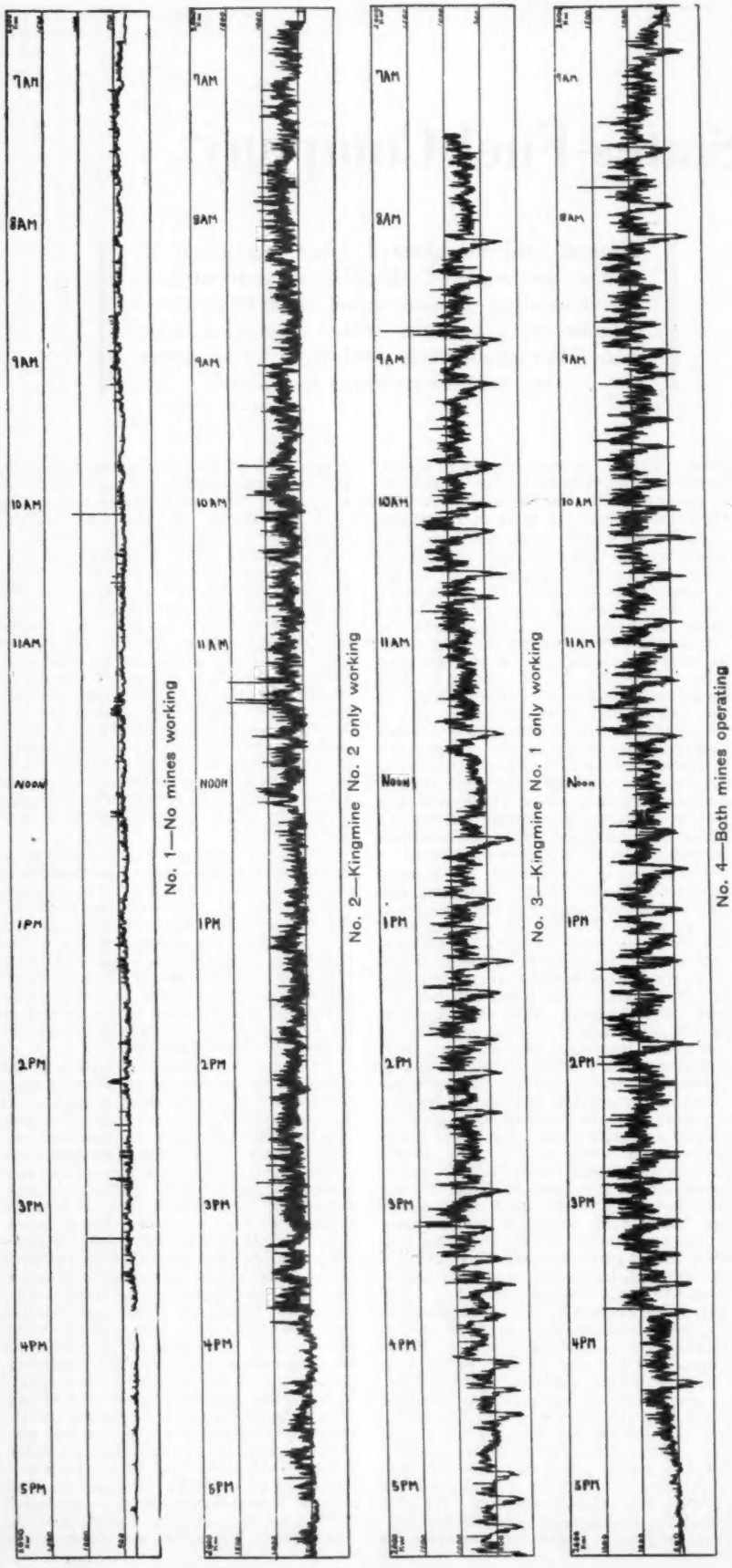
The power requirements for these three mines are supplied through one central substation in which the electrical energy is received in the form of three-phase, 60-cycle alternating current at 44,000 volts. Several sets of transformers distribute the current to the different mines at varying voltages. To the furthest mine, Kingmine No. 2, about 6 miles away, transmission is at 11,000 volts. To the neighboring mine, Kingmine No. 1, current is carried at 440 volts to the immediately adjacent tipple, shops, and townsite, and at 2,300 volts to the mine proper. To the Hiawatha mine, nearly 3 miles distant, runs an 11,000-volt line. For general motor purposes outside the mines, such as shops, tipples, etc., current is used at 440 volts, three-phase, a.c.

Underground distribution for locomotives, mechanical loaders, scrapers, cutting machines, pumps and compressors is by the 250 to 275 volt direct current of the trolley system. Originally this current was all supplied from motor-generator sets located at the portals. As long as the working faces were not far distant underground, this arrangement proved satisfactory. Interruptions to operations through overload or short circuit were minimized by self-reclosing automatic circuit breakers. With the advance of the entries, however, it became apparent that the voltage drop was becoming excessive despite the use of heavy feeders and heavy rail, 40 and 60 lb., thoroughly bonded with welded copper bonds. With the speed of direct-current machinery dependent upon the voltage any heavy drop would, of course, slow up the operations. To improve this condition motor generator sets were installed underground in the two operating mines, three-phase alternating current at 2,300 volts being carried to them through three conductor lead-sheathed armored cables. As arranged at present, therefore, Kingmine No. 1 has one 360-kw. motor generator set at the portal and one 200-kw. set about 6,400 ft. inside, while Kingmine No. 2 has one 300-kw. set at the portal and one 300-kw. set about 7,500 ft. inside. Approximately midway between the two motor generator sets in each mine there is installed a sectionalizing self-reclosing circuit breaker. By this means the underground distribution systems, although operating normally as single systems with two generators feeding into each system, are each instantly segregated into two separate sections in case of trouble on any one section. Should there be a short, an overload, or like trouble on either side of the sectionalizing circuit breaker, that side will be automatically cut out of the circuit and remain dead until the trouble is cleared. In the meantime the other side of the system continues to operate without delay, fed by the generator on that end. Once the trouble is eliminated the circuit breaker mentioned automatically recloses and the two ends of the system are tied together, once more operating as a single system. This arrangement has proven of great convenience, eliminating many delays formerly experienced when the whole underground system would go dead on account of trouble experienced in some remote section.

These experiences are a further testimony to the advantages of sectionalizing the distribution. The very best arrangement would be, of course, to subdivide the system into quite a number of sections. The service given, however, by the automatic sectionalizing breakers and the self-reclosing breakers at the generators themselves has proven so satisfactory under the present plan of operations as to make further sectionalizing at the moment of small advantage.

The long three conductor cables to the underground motor generator sets were the subject of considerable thought. At Kingmine No. 2, for example, the cable receives current from an outdoor substation where the voltage is stepped down from 11,000 volts to 2,300. This substation is protected by lightning arresters on the high-tension side. It was uncertain whether arresters should be applied on the low-voltage side. Shortly after putting the cable into operation it broke down, resulting in the burning out of one of the transformers. After a long search the break was found in a junction box. Whether this was due to a defective joint or to line surges could not be determined with absolute certainty, although suspicion pointed more strongly to the latter, particularly in view of certain voltage fluctuations shown on the recording voltmeter at the central substation. Bearing in mind that an underground cable may tend to act as a condenser and thereby exaggerate line surges, it was deemed wise to protect it with a set of oxide film arresters of the pellet type. Since this was done, on the

*Chief Engineer, United States Smelting, Refining & Mining Co., Salt Lake City, Utah.



cables at both mines, there has been no further difficulty. These arresters are simple and inexpensive, and it is believed that it is good practice and good insurance to protect underground cables with them and not depend on arresters on the high-tension lines alone.

The application of power to mining operations is being gradually extended. The so-called mechanization of mining is entirely dependent upon a reliable source of power. Some years ago two different makes of power shovels were tried out, but did not prove satisfactory. Later on a system of sectional drag-chain conveyors was experimented with. On account of the high roof and the cumbersome nature of the conveyors in comparison with the tonnage handled, the results obtained were inconclusive. At first it seemed as if a saving in loading costs were being effected, but when all the factors involved, particularly the heavy repairs and depreciation of the equipment, were taken into account it was not so certain. More recently Joy loaders have been tried out. Where conditions are suited to the use of these machines they have proven quite effective. At present two of these loaders are in operation in Kingmine No. 1 and three in Kingmine No. 2. These were not all purchased at one time but were installed gradually as they demonstrated their practicability. As experience is gained in their operation and the crews become more skilled in maneuvering them the results obtained continue to improve. Unavoidably, machines of this kind involve the use of considerable mechanism. Unless handled intelligently this mechanism can be abused, resulting in considerable repair cost. It is felt also that parts of the machines are susceptible of further improvement. Taken as a whole, however, they are clever conceptions and are giving encouraging results, as is evidenced by their increased application.

Loading by scraper has also proven successful in particular sections adapted to the device. The scraper used is of the box type, with vertical parallel sides, open top and bottom, with a vertical swinging plate between at the rear. As the scraper is pulled back into the coal pile this plate swings up, allowing the two parallel sides to work back into the coal. On drawing forward, this back plate drops down until it comes into contact with stops which hold it approximately vertical, constituting the pressure member which pushes against the coal in dragging. It is, in other words, something like a check valve. A Sullivan 25-hp. two-drum hoist, specially designed for this kind of work, affords the tractive effect through a ⅝-in. wire drag rope and a ½-in. tail rope. The scraper discharges into the hopper of a conveyor loader, formerly used with a Jeffrey mechanical entry driving machine. This makes a good feeder for loading the mine cars which run past at right angles. A second unit of scraper loader is now being prepared for operation.

These two different types of loaders, the Joy loader and the drag scraper, are effecting distinct economies through the substitution of electric power for human energy. The results are so promising that the attitude at present is to use power wherever possible. As one small, yet important, application might be mentioned the use of a number of electric coal drills in place of the old hand augurs. This is a device which seems to deserve still further application. For cutting the coal, machines of the Goodman, Sullivan and Jeffrey makes are in use. While

these cutting and loading devices constitute a considerable step forward, it is certain that the ultimate possibilities in the use of power are yet far from being realized.

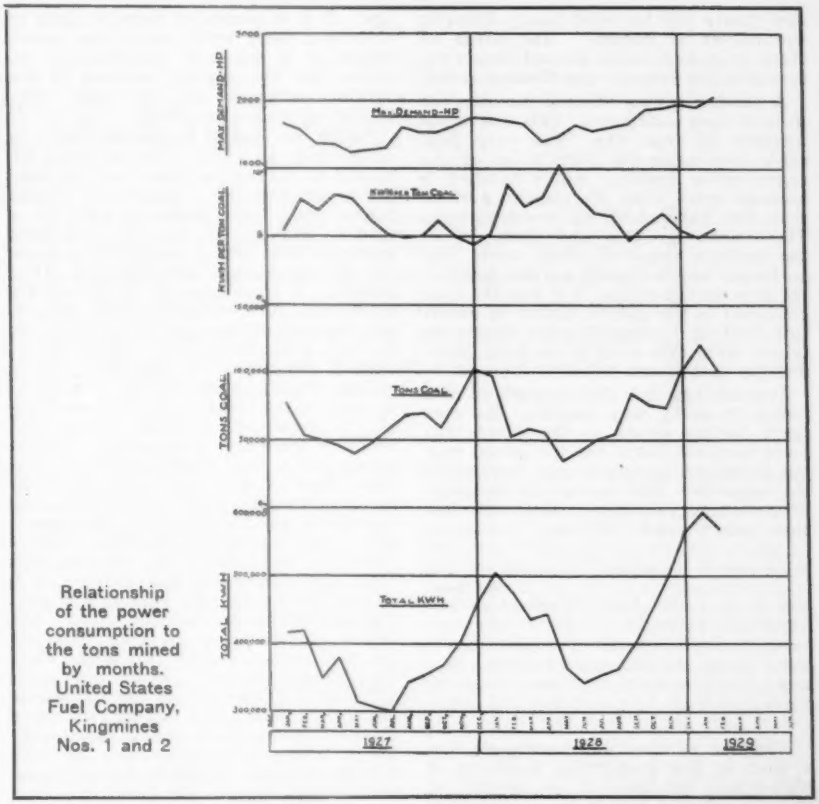
Main entry haulage in both mines is handled by 10 and 15-ton, 250-volt trolley locomotives. For gathering work there are used 5 and 6-ton reel locomotives and combination storage battery and trolley locomotives, rated as 8-ton with their batteries and 6-ton without. These combination locomotives are of great convenience, as they can be charged directly from the trolley lines and are ready at any time to go into workings where the trolley system has not been extended. Curiously enough, there is some difference of opinion amongst operating men as to which is the better gathering locomotive, the cable reel type or the combination storage battery and trolley type. One advantage of the latter is that the storage batteries can be charged at night when the mines are not operating and thereby avoid some peak load on the power demand.

This last point leads on to a consideration of factors concerned with the economical use of power. Whether power be derived from a privately owned plant or purchased from an outside utility it is desirable to avoid excessive peaks in the demand. Coal mines generally are notorious for the poor load factors developed in their operations, firstly because of the usual custom of day-time work only, and secondly because of the seasonal variations in the working time. Anything which can be done to improve the load factor will in turn improve the service and lighten the cost. At the mines under discussion as much power as possible is used at night instead of in the daytime. For example, the pumps supplying water to the storage tank above Kingmine No. 1 are operated after the heavy day load is off. At the inoperative Hiawatha mine the fans are run for a few hours each day to keep the air clear and this service is also performed at night.

The motor generator sets supply D. C. current for underground work are equipped with synchronous motors, whose well-known condenser effect helps to maintain a good power factor on the distribution system. Only lately does the importance of high-power factor seem to be realized, and not generally at that. The impression still prevails that low-power factor simply represents a certain amount of "wattless" current; in other words, current which does not involve kilowatt hours and therefore costs nothing. That this is a mistake will be apparent on further reflection. There is an unavoidable loss of power in every transmission line from the metering point to the points of consumption—the motors, lights, heating devices, or whatever they may be. This loss is mostly that known as the I R, varying as the square of the amount of current carried in the distribution line. As the power factor indicates directly the relative amount of current carried, it must be evident, therefore, that the transmission loss varies inversely as the square of the power factor. Assume a distribution system with an average drop of 10 percent, or a transmission efficiency of 90 percent, and a power factor of 90 percent. Let the power factor then drop to 70 percent. The loss will then be

$$10 \text{ percent} \times \frac{.9^2}{.7^2} = 16.5 \text{ percent.}$$

To be sure, the exact figures for alternating current work are not as simple as that. But for all practical purposes these figures may be considered approximately correct. In addition to avoiding the overloading of transmission lines and transformers or eliminating the necessity of using excessively large sizes, high-power factor therefore does actually save power which would otherwise be wasted as useless heat. The ordinary mine can usually do little to improve its load factor, but there are many things that can be done to maintain a good power factor, such as the use of oversize synchronous motors, keeping motors of the induction type well loaded up, using as high-speed motors as possible, and so on.



Relationship of the power consumption to the tons mined by months. United States Fuel Company, Kingmines Nos. 1 and 2

One interesting method of saving power and effecting other economies at these mines came about from a study of the gravity tramway machine at Kingmine No. 1. At this mine "trips" of 17 3½-ton cars are lowered from the portal at an elevation of 7,944.70 ft. to the tipple at an elevation of 7,224.78 ft. on a double-track incline about 5,842 ft. long, measured on the incline. Through the medium of a 1½-in. special wire rope the descending loaded cars pulled the empty cars back to the tipple. This rope wound over tandem sheaves equipped with Walker differential rings, braking being effected by band brakes controlled by pneumatic cylinders. For a long time the life of the ropes used was disappointingly small. Intense study was given to the problem and various suggestions made and carried out with some small improvement. About this time the writer took up the study and became convinced that the difficulty lay in the braking system. The pneumatic cylinders operating the brakes had no tandem oil cataract cylinders with floating levers to make the movements positive, as is the general practice on large hoists. As a result, the movements of the pneumatic pistons were jerky, "springy." This in turn caused the rope to slap up and down on the rollers, with excessive wear as the final outcome. Plans were thereupon laid to equip the machine with the proper tandem cataract cylinders above the pneumatic brake cylinders.

At this stage the engineers of the General Electric Co. suggested the gearing of a large motor to the hoist machine with the idea of regenerating power instead of wasting it in mechanical braking. As this idea looked better than the first one, they were commissioned to go ahead. A 500-hp., 3-phase, 60-cycle, 2,300-volt motor of the phase wound or "slip-ring" type, together with a control panel of the automatic current limiting relay contactor design was built and geared to the tramway machine with herringbone gears. The brakes were used only to bring the trips to an exact stop as they approached the ends of their travel. During the greater part of the trip the only braking was magnetic or the pull of the hoist against the motor.

The results obtained were immediately found of real benefit. In the first place, the speed was uniform instead of erratic or according to the judgment of the hoistman in applying the brakes as heretofore. In the second place, a real saving in power was noticeable. The accompanying reproductions of graphic wattmeter charts tell the story quite well. No. 1 is the record when no mines were working, power being used only for fans, shops, lights, and such like. No. 2 is the condition with only Kingmine No. 2 working. No. 3 is the power demand with No. 1 working, while No. 4 is the record with both mines operating. On the latter

two charts will be noted heavy drops in the curves of demand. The areas of these drops represents kilowatt hours returned to the system—and thereby saved.

A further saving effected proved even greater than anticipated. This was in the increase of rope life. The very first cable used after the installation of the regenerative braking motor handled a tonnage more than 50 percent greater than that handled by any previous rope. The reason for this was plain. With the uniform speed obtained, there was no longer any whipping up and down of the rope on the rollers, nor was the rope subjected to the sudden strains of uncertain braking. Altogether the results obtained from this installation fully justified the enthusiasm which it aroused.

Yet although it is felt desirable to save power in every way possible, the contrary feeling exists to the effect that more kilowatt hours per ton mined may not represent increased cost but rather the opposite. The annual consumption of power for all three mines the last three years was as follows:

Year	Kw. hours.	Tons mined.	Kw. hours per ton.
1926	4,662,673	786,068	5.93
1927	4,737,095	873,699	5.42
1928	5,484,592	889,201	6.17

Nineteen hundred and twenty-six was a year of low production, resulting in high-power consumption on account of the necessity of keeping non-productive machinery such as fans running. Yet in 1928, when the production was much greater, the power consumption per ton was even higher. It was in this year that loaders and scrapers began to be more extensively used. This resulted in a greater demand for power than ever before. Nevertheless, it was felt that this was using advantageously the cheapest kind of labor available, namely, electric power. It will not be surprising to see an even greater increase in the kw.h. per ton of coal mined.

A chart is also submitted showing the relationship of the power consumption to the tons mined by months. It is immediately apparent that curve of kw.h. per ton mined is exceedingly irregular. At first glance it seems scarcely consistent. It does, however, show the marked effect of the seasonal variations in production on the consumption of power per ton mined. Not only is the consumption per ton greater in the dull season but the cost per unit of power is also higher by reason of the poor load factor.

A rather unique feature of the operations of the United States Fuel Co. is found in its dairy ranch, a few miles from Hiawatha, established to solve the problem of securing pure milk for its employes. Here some 40 head of pure-bred Holsteins are regularly milked, in addition to which the ranch supports an increasing herd of young stock. The ranch is mentioned here only as an example of the manner in which power is applied everywhere possible. Besides the pumping system for domestic water, power is used for lighting, vacuum milking machines, forage and ensilage cutters, refrigerating machinery in the milk-bottling house, and such like agricultural machinery as well as a tractor for haulage. It is a somewhat unusual sight to observe a dairy which, under the supervision of a graduate veterinarian, receives also the regular services of the master mechanic and the chief electrician of the mines proper.

Let it be clearly understood that in submitting the above notes it is not intended to convey the idea that the manner in which power is used in the United States Fuel Co.'s mines is ideal or a model. We are all far from satisfied and give this record simply to indicate the efforts toward improvement. For example, in some cases D. C. motors are used where A. C. would be more efficient. But the cost of changing over would offset the possible saving. Then, again, there is the question of whether the mine safety practices are entirely consistent in view of the manner in which so much D. C. machinery is used underground with its tendency to sparking. Fortunately the United States mines are entirely free of gas and have never yet in their many years life given any trouble in this respect. Yet these mines have loyally supported the state regulations for mine safety in order to promote the welfare of the district as a whole. Thorough rock dusting and regular sprinkling are insisted upon. The taking of matches or smoking materials into the mines is strictly forbidden. Electric storage battery lamps are used. Electric shot firing from the outside is the rule. Yet after noting all these elaborate precautions one is startled to see a trolley locomotive tear by with a long streamer of sparks flying behind the trolley wheels. In fact, this is a point needing real attention, namely, the invention of a sparkless contactor with the trolley wire. Perhaps such a device has already been gotten out. If so, it should be made known and put into more general use. Some mines have, in fact, been compelled to use storage battery locomotives exclusively on account of the dangers of trolley wire sparks. Yet this is not a good solution, if one bears in mind that storage batteries return not much over 50 percent of the stored power.

The natural question may be asked why a coal mine, producing the fundamental raw material for the production of power, should buy its own power from outside. The answer is simple, being based on two essential considerations. In the first place, the coal mines of Carbon County, Utah, are located in an arid region where water is so scarce that there is difficulty in securing sufficient for the direct mining and domestic purposes. Without an ample supply of water a steam-power plant can not be efficient. In the second place, the load factors of coal mines are very low, for reasons beyond their control. It is self-evident that a power plant of sufficient size to take care of the maximum peak demands during the busy seasons, but compelled to operate at a low rate during the dull season would have an unduly heavy capitalization cost assessed against the net production. A large interconnected power system serving many varied interests would, by reason of its better diversity factor, be able to maintain the production of power at a more uniform rate, and therefore at a lower cost per kw.h. In addition to these two factors, there is the well-known advantage and better economy of producing power from large units than from small ones. So marked are the economies of central station operation that even coal mines located in districts with ample water supply find it cheaper to buy their power than to make it themselves.

It is becoming increasingly evident that coal mining must be prepared to use an even greater quantity of power per ton mined than has been the case in the past if it would prosper under the present conditions of severe competition. Fewer mines with heavier production concentrated from smaller areas will make for lower unit costs. The mechanical engineers have already done some wonderful work in making it possible to more extensively utilize that cheap servant of industry—power. That further advance is in sight goes without question. Such advance will release more and more men from the treadmill of existence where life meant but little more than 1,296,000 foot pounds of work per day.

POWER PROBLEMS in BITUMINOUS
(from page 690)

The power cost per ton of coal in the average bituminous mine is approximately only 6 percent of the total cost; nevertheless, the actual cost of power supply is not the only consideration. Costs incidental to the cost of supply must be given foremost consideration, and I would judge that it is as impractical to operate a coal mine without the aid of an electrical engineer as it is to operate without a civil engineer.

Those of you who obtain your supply by purchase have no doubt experienced some difficulty in the interpretation of rate schedules and regulations governing the service. I am, of course, not in a very safe position to criticize the practice and policies used by the utility companies in this connection, but I will venture to state that the big power-producing companies in a great many cases are beginning to realize the unpopularity of power schedules which tend to be complicated, and even in some cases have an air of antagonism. The drift seems to be towards the simplified method of framing rate structures and contract forms. It is, however, a very difficult problem to frame a power rate schedule which in its simpler form will prove equitable to all customers under all conditions. Kinks of this kind will naturally be ironed out as the producer and the consumer come in closer contact with each other's problems.

A summary of this, more or less, generalization includes the problems, in my opinion, most outstanding in the application of electric power to the production of bituminous coal:

(1) Supply and regulation.

(2) Working schedule relating to load factor.

(3) Type of equipment and its maintenance.

(4) Records showing distribution of power to various phases of production.

(5) Engineering practice.

It is not the intent of this paper to propose any particular plan nor to promote any new theories, but only to call your attention anew to the old subjects and old problems which have not been properly pursued, even though they may have been once solved.

Some Notes on
Mining PITCHING Coal Seams

Synopses of coal beds and seam conditions in the State of Washington—Methods of timbering under various classes of roof—General landings and turnovers for slope haulage—Mining plan by chute and pillar and longwall—Modified systems for special seam or roof conditions—"Bounces" under heavy cover

By GEORGE WATKIN EVANS *

THIS paper is not presented as a very comprehensive treatise on the subject of mining pitching coal seams. I will present some pictures of coal mining as applied to some of the pitching seams in the state of Washington, and will take advantage of several sketches and drawings published in Bulletin No. 190, of the United States Bureau of Mines, of which I am the author, and using these sketches for illustrating purposes, I will discuss the methods of mining.

It will be of interest to those present who are not familiar with coal mining in the state of Washington to know that in that state there are coals ranging in quality from low-grade lignites, in the southern part of the state, on the Columbia River, to coking bituminous coal in Pierce and King Counties and some anthracite in the eastern end of Lewis County, also at the Carbonado mine in Pierce County, and a deposit of anthracite on the northwestern slope of Mt. Baker, near the northern boundary of the state.

The coal beds of Washington are of Eocene age and, where the folding and faulting is not of an intensive nature, the coals are either lignitic or subbituminous. But in the areas where folding is close and there is considerable faulting, the coal has been metamorphosed into a bituminous coal, and in many instances into coking bituminous coal. The anthracite deposits in the state have been formed either by intensive folding and faulting or by intrusive rocks.

I believe I am safe in saying that the coal beds of Washington contain a greater variety of coals than any other state in the Union and, because of the intensive folding and faulting within some of the areas, the mining problems are more complex than in most states.

I have followed the mining history of the state of Washington very closely for the past 40 years. Ever since I arrived, as a boy, in the King County coal fields. The coal miners working in the coal fields in King and Pierce Counties were made up very largely of men who migrated from the anthracite fields of Pennsylvania, and the names of Shamokin, Pottsville, Wilkes-Barre, and Scranton were to be heard on all sides, especially in conversation with the Welch coal miners. The best miners we had in those days were men who came from the highly pitching seams of the anthracite fields of Pennsylvania. Many of the mine managers and most of the mining engineers were brought out from Pennsylvania to lay out the mines and operate them.

The method of mining employed in the early days were the methods used in the Pennsylvania field, but as time went on the local managements discovered that certain modifications had to be made in order to overcome the difficulties peculiar to the western Washington fields.

At first they used the chute and pillar system or the breast and pillar system, depending upon the character of roof. If the roof was short grained and heavy, then narrow chutes would be driven from the gangway up the pitch to a predetermined chain pillar. Where the roof was stronger, a wider opening, called a breast, was driven and the mine worked on the breast and pillar system.

In the early history of mining of the state there were numerous water-level drifts and water-level rock tunnels driven in order to mine the coal, that was easily available above the general level of the district in which the mine was located. After the water-level coal was mined, it then became necessary to sink slopes or shafts to recover the coal below water level. In the early days, slopes were sunk on the full dip of the coal bed regardless of its dip, but in later years, if the bed dipped at a high angle of, say, 70° or 80°, the slope was driven across the pitch at an angle of about 35°. It is found to be much more difficult to sink the slope on a 60° dip than on the 35° dip, and when it came to repairing the slope, the heavy pitching slopes proved to be extremely expensive and dangerous to repair.

At first, in slope sinking, the turnouts on each level were made on either side of the slope in the coal with suitable surface curves, so as to bank the outer rails on the curves. It was found, however, that in order to land a trip of cars on the top with sufficient speed it was, likewise, necessary to have the same rate of speed for the cars in landing on the bottom, and very often the cars would not take the curves properly, with the result that wrecks would frequently occur. This difficulty was overcome by making turnouts in the rock as indicated in *Figure 1*. By referring to this figure you will notice that a slope is sunk on the main dip of the bed at an angle of about 40°. From the bottom of the slope at that level, a short rock tunnel is driven on proper grades and on proper curvature around to each side of the slope, back to the coal seam. The runabout, as it is called, is wide enough to contain double tracks on each side, and the tracks are graded in such a manner that empty trips will run away from the bottom of the slope into a gathering pit for the locomotive, and the loaded cars will gravitate to the bottom, so as to be ready for the chain as soon as it is taken off the empty trip. Track arrangements are made near the bottom of the slope so the trips can be taken into either side without difficulty or confusion.

In some instances, pilot slopes have been driven narrow from one level down to another, and this pilot slope used later as a return airway on one side of the slope. The gangway was then driven across the slope pillar in coal to a point directly below the center line of the proposed main slope and the main slope driven up the pitch. The material handled through chutes at the bottom of slope; loaded into cars and hoisted up the pilot slope. The return airway on the other side of the slope was driven in the same manner. With this system of working the cost of slope driving is reduced to a minimum and is found to work very well. *Figure 2* shows an approved method of timbering a slope.

In driving gangways, the systems illustrated in *Figures 5-6-7* are used in some of the mines. Where the roof is exceedingly strong a post and lagging only are used; where the roof is not strong, three-piece sets are used; and in other places where the roof is moderately strong, the type of timbering illustrated in *Figure 7* is shown.

Above the gangway is a return airway, or counter, or, as our anthracite friends call them, a monkey gangway. This is also shown in *Figure 1*. A chain pillar is left immediately below the gangway above. This is shown in black under the third level in *Figure 1*.

Where the character of the roof will permit, wide breasts are sometimes driven as much as 70 ft. in width, with suitable pillars between breasts. The width of the pillars are dependent upon the depth of that particular part of the mine and the resulting pressure due to depth of overburden. When a fault is crossed in driving a breast, which is frequently the case, suitable blocks of coal are left both above and below the fault, in order to help carry the roof. This is shown in *Figure 8*.

Mining machines in the form of post punchers have been used in western Washington for the past 12 or 15 years. *Figure 9* illustrates the methods of setting up the post puncher and the successive cuts in a breast 70 ft. in width. The pitch of this mine was approximately 40°. The method of ventilating the working

* Consulting coal mining engineer, Seattle, Wash.

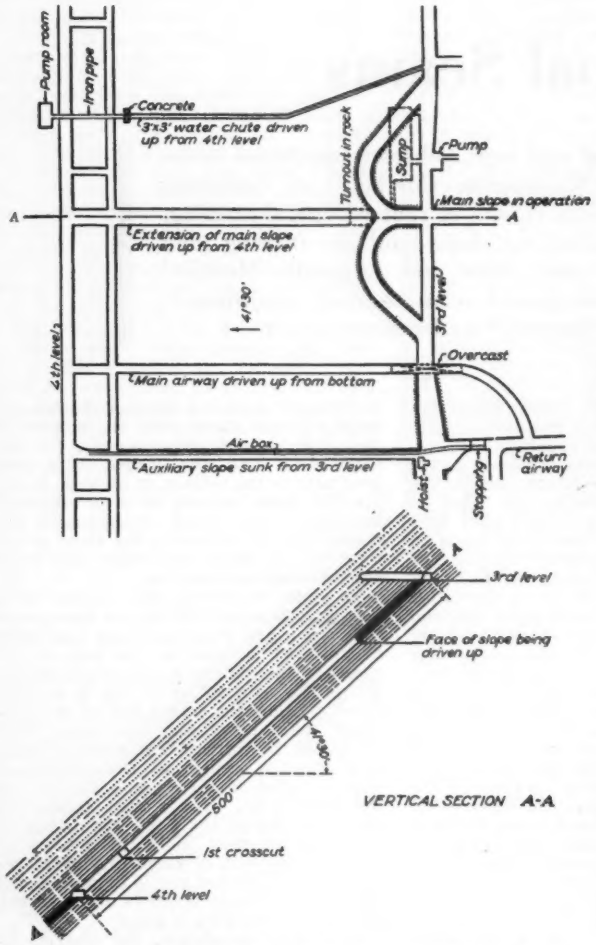


Figure 1. Method of slope development used in coal bed 5 ft. 8 in. thick; dip 41° 30'; both walls shale

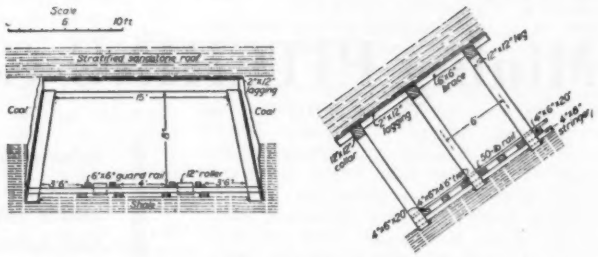


Figure 2. Cross sections of double compartment slope, showing method of timbering; dip, 45°

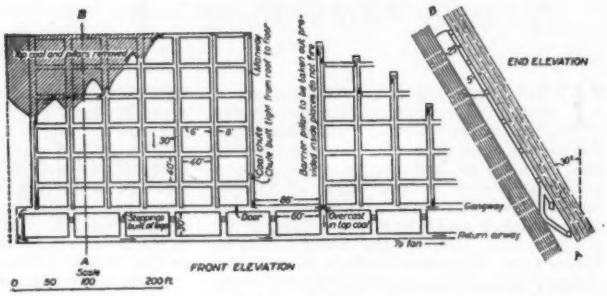


Figure 3. Chute and pillar system of working a 25-ft. bed of bituminous coal; dip, 30°

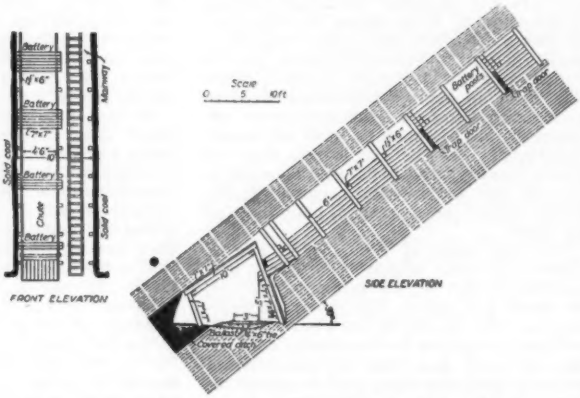
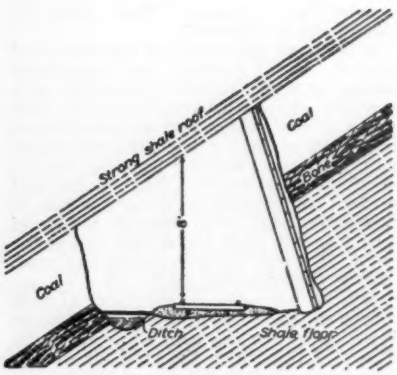
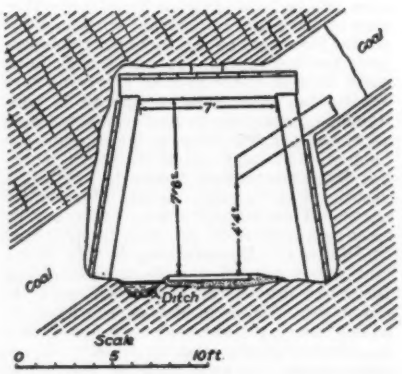
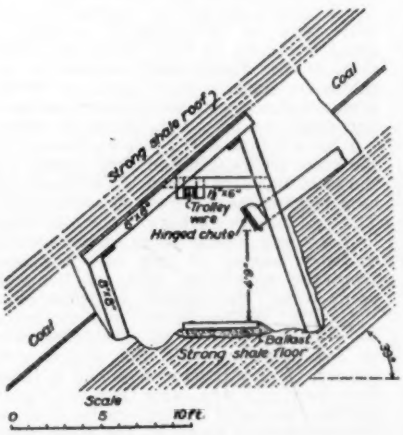


Figure 4. Elevations showing method of timbering gangway and chute in coal bed with shale walls; dip, 38 to 41°







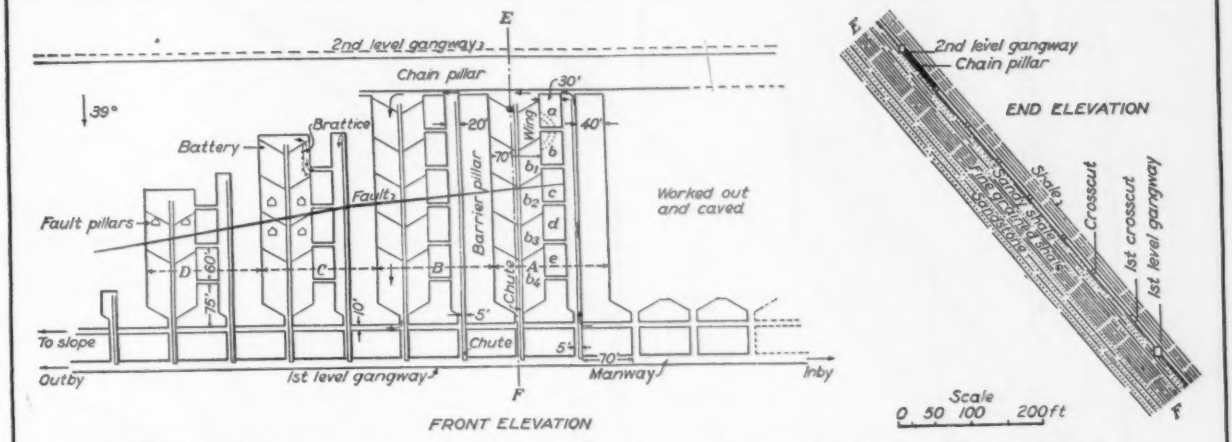


Figure 8. Method of working coal bed 5 ft. 8 in. thick; top and bottom shale; dip 39°; produces some gas

face is fully illustrated in the drawing and the method of bringing the coal to the central chute is also shown, by placing wings from each rib toward the center. A good ladderway is maintained up the breast, and suitable planks and props are used near the working faces for the men to work on while handling the mining machines and doing their other work.

Figure 11 shows a method of modified longwall that was tried in this same mine in another coal seam where the roof conditions were entirely different. By examining the drawing carefully, you'll observe that immediately above the coal bed is a bed of carbonaceous shale and bone, and above the stratum a jointed sandstone. The reason I mention these features is because the peculiar nature of this roof had direct bearing on this problem.

The method of doing this longwall work was to drive a pair of chutes on each side of a panel of predetermined width. In this instance the width was equivalent to 13 chutes between a barrier pillar to the left. Chutes were then driven up from the gangway, about half the width of the lift to be mined. One chute was driven up to a top counter shown in the cut, and then a longwall face was started from this point diagonally across the pitch. A sheet-iron chute was carried reasonably close to the stepped longwall face and log-cabin cogs placed between the chute and the caved ground. It was thought for a while that this method of mining would be successful, but after a certain area was opened and the first roof had caved immediately above the coal bed, the second roof, consisting of jointed massive sandstone, caved, and then the main sandstone roof began to come down, and when this happened it would override the longwall face and smash timber, cogs, and sheet iron. The management did not continue with this system very long. It is probable that a solution by certain modifications could have been worked out.

Within some of the coal areas the mines are troubled a great deal from intrusive dikes, and the coal is destroyed on both sides of the dike for some distance. These intrusions are extremely difficult to drill through, so that the number of openings through them are reduced to a minimum. By referring to *Figure 12* you will observe the diamond

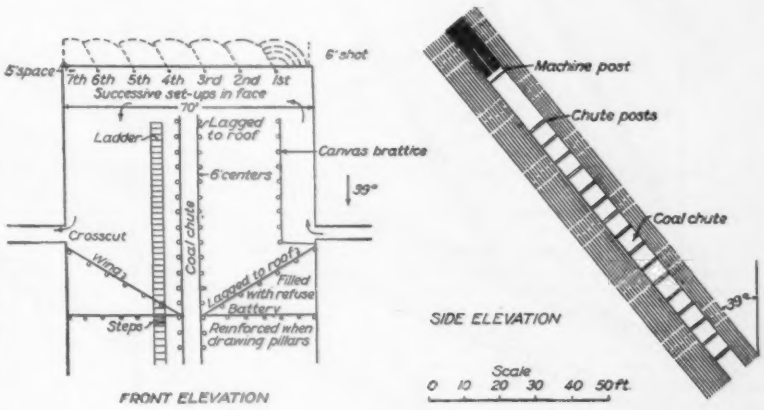


Figure 9. System used when mining with Sullivan post punchers in 70-ft. breasts

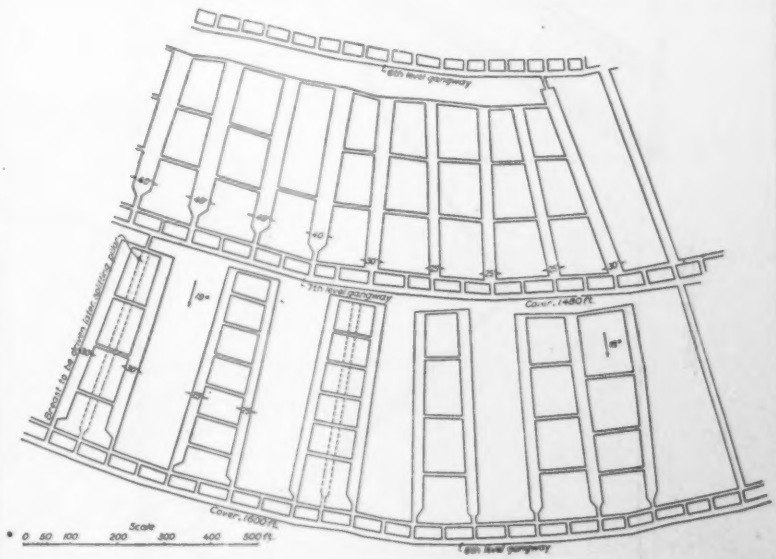


Figure 10. Breast and pillar system of working 6-ft. bed; good sandstone roof; dip, 18 to 19°

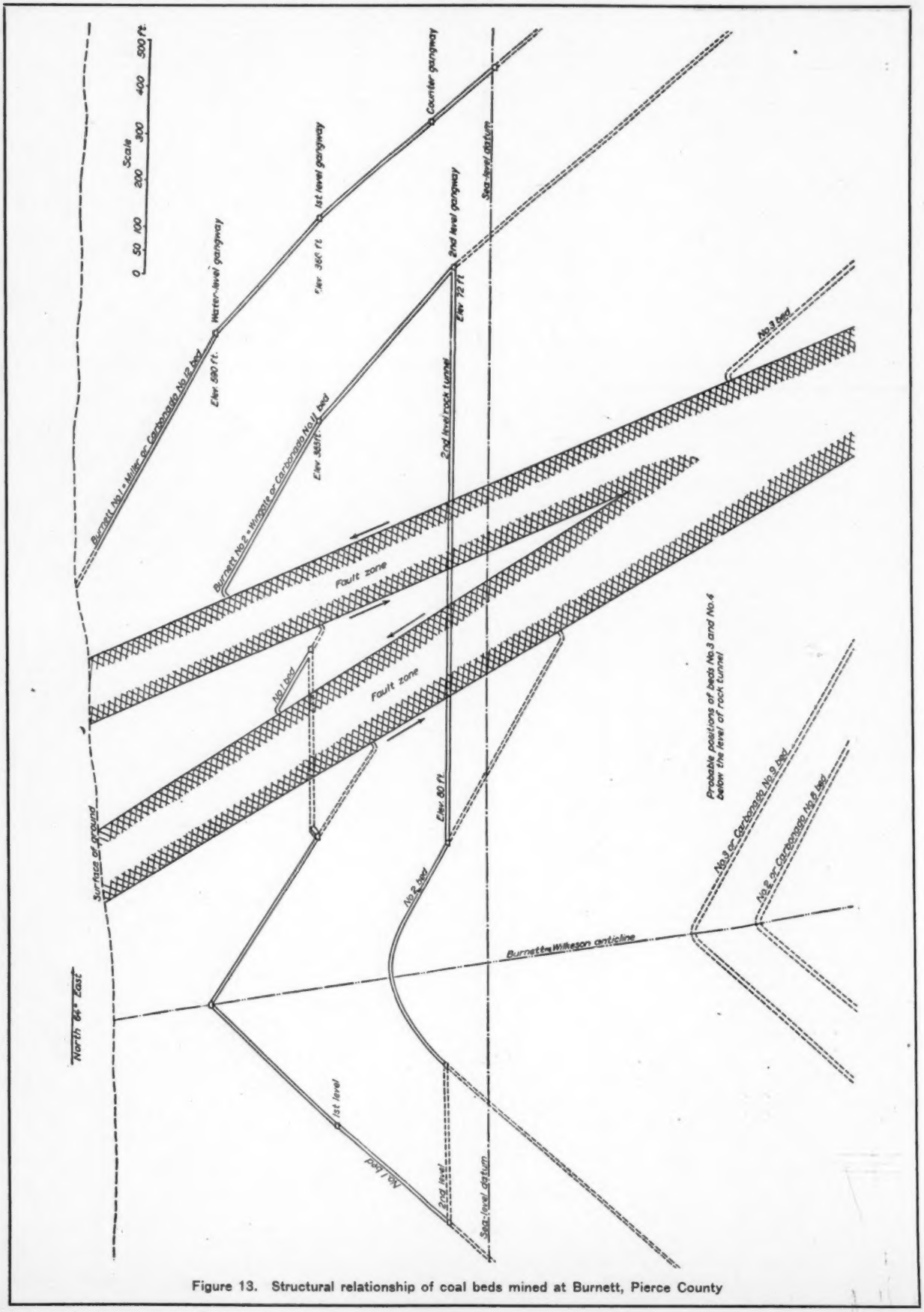


Figure 13. Structural relationship of coal beds mined at Burnett, Pierce County

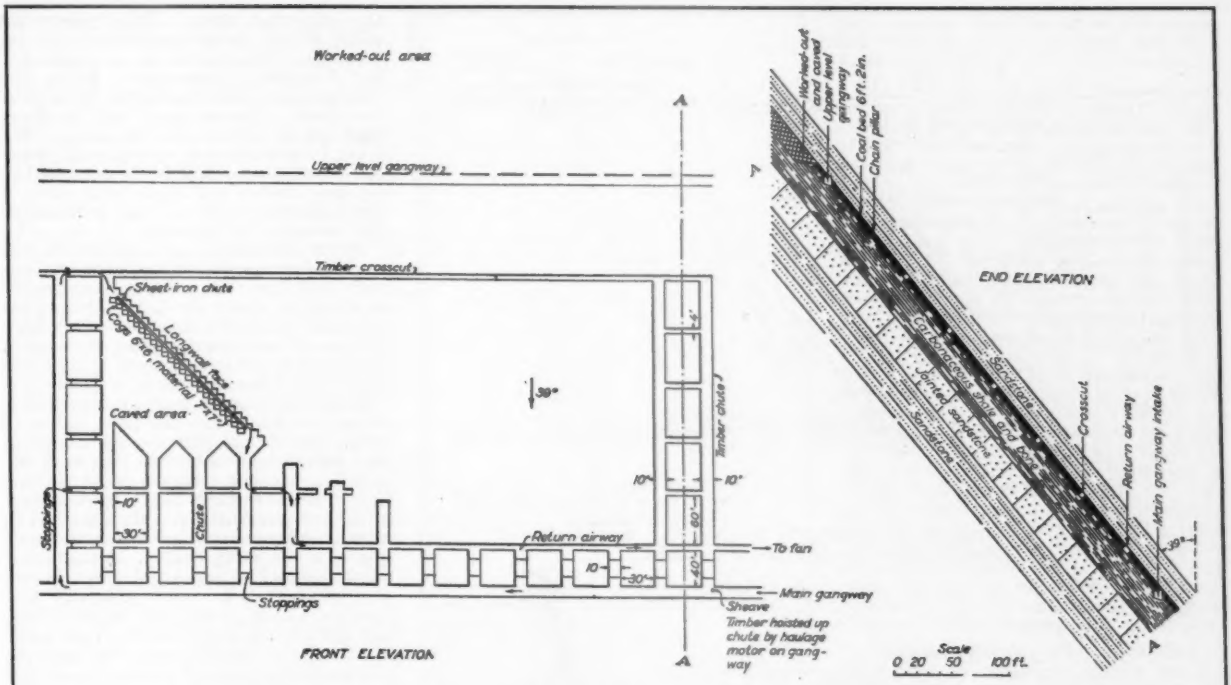


Figure 11. Panel longwall system for coal bed 6 ft. thick; dip, 39°; roof, bone and carbonaceous shale, 27 ft. thick; sandstone over bone

or diagonal chute system used in a coal bed where the dip is 70° and where the bed is cut through by an intrusive dike. By driving an occasional chute through this rock and connecting this with several chutes above the intrusion, it has been found that a smaller number of chutes through the intrusion will serve the purpose. After the chutes were driven in this mine the blocks of coal between the chutes and crosscuts were removed by starting at the chain pillar at the top of the lift and caving the blocks into the nearest chute. This system then became a modified form of longwall retreating, with the chutes and crosscut acting as gateways.

By referring to *Figure 13* you will observe the folded and faulted condition within a portion of the Pierce County coal field. It will be observed that the No. 1 bed is crossed in this mine three times on the eastern dip within the area east of the anticlinal. There are two large thrust faults cutting through these almost paralling the axis of the folds.

In one of the mines where the beds are dipping at an angle of 80°, a series of diagonal chutes are driven so that the angle of the chute is about 45°. In *Figure 15* you will observe that six chutes are driven in a diagonal manner 6 ft. by 6 ft. in width on the lower bench of an 11-ft. bed of coal. These chutes are driven to the chain pillar. Chutes No. 1 and No. 6 are driven through to

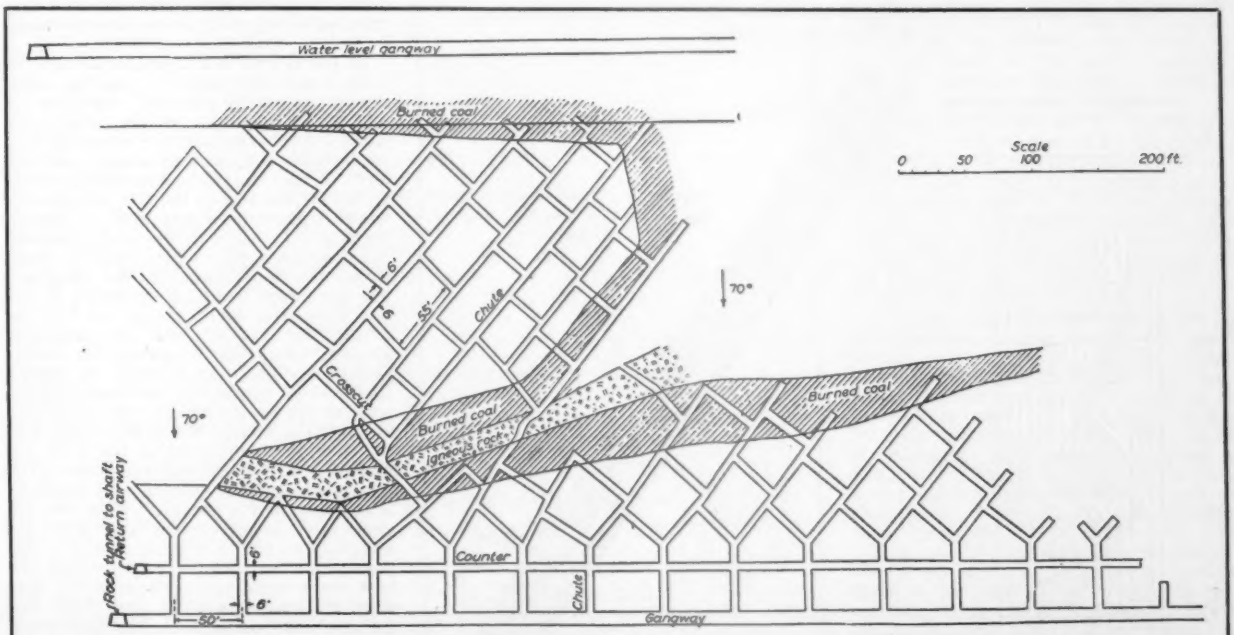


Figure 12. Special chute and pillar system with diagonal chutes; used in Taylor mine

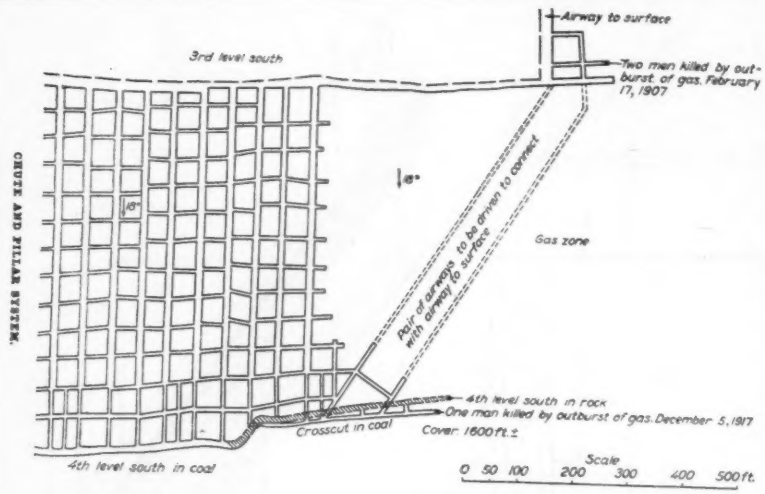

Airway to surface
3rd level south
Two men killed by outburst of gas, February 17, 1907
CHUTE AND PILLAR SYSTEM
Gas zone
Pair of airways to be driven to connect with airway to surface
4th level south in rock
One man killed by outburst of gas, December 5, 1917
Crosscut in coal
Cover 1600 ft.±
4th level south in coal
Scale
0 50 100 200 300 400 500 ft.

Figure 14. Locations of gas outbursts in Wingate Mine; also, method of rearranging workings to avoid outbursts

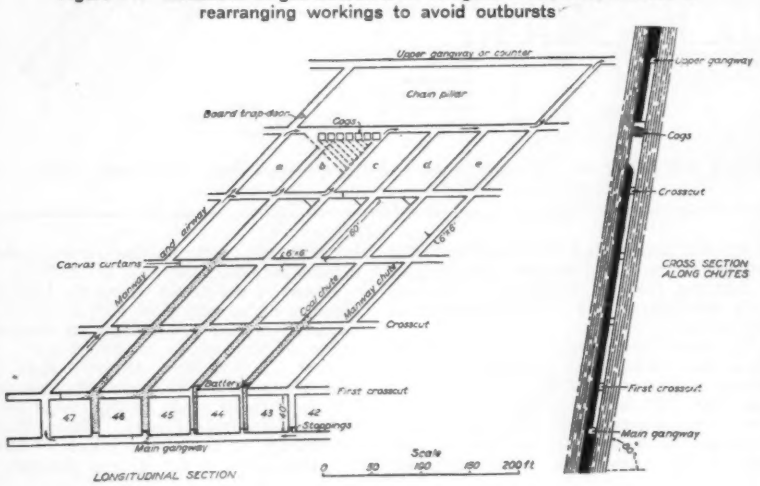


Figure 15. Chute and pillar system used in working 11-ft. coal bed with dip of 80°, Wilkeson Mine

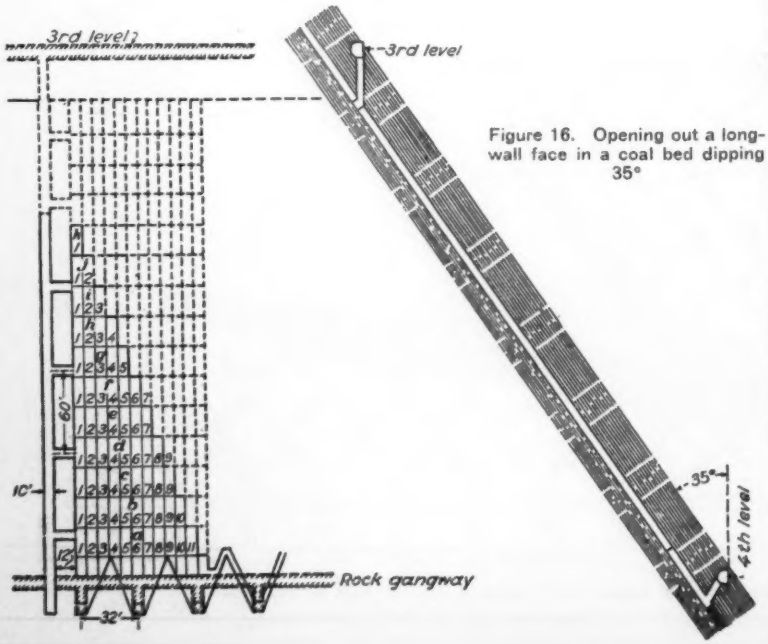


Figure 16. Opening out a longwall face in a coal bed dipping 35°

the gangway above. The reason for doing this is as an escapement for the men, also for ventilating purposes and for dropping timber down to be distributed along the counter at the tops of the chutes. Chutes No. 1 and No. 6 are used as manways and airways. The other four chutes are used as coal chutes, and where the breakage of coal is a factor the chutes are kept full. Only a small percentage of the coal is mined in this mine in first mining.

After the chutes are driven to the chain pillar a series of log-cabin cogs are built and then the pillars are removed by skipping, shown by dotted lines in the drawing. In this manner we again have a form of modified longwall retreating. This system worked out very well in this mine and, as far as I know, is still in use.

In several instances in western Washington we have, for the past 15 or 16 years, resorted to the use of rock gangway and rock chutes connecting with the coal bed. In one instance in particular, this system worked out very satisfactorily and permitted the management to mine a seam of coal in which the roof was of a squeezing nature. A chute and pillar system had been tried, also a breast and pillar system. Rock gangway was resorted to and a stepped longwall system introduced, as shown in *Figures 16-17*. In *Figure 16* the method of opening this longwall is shown in detail, and also the positions of the rock gangway at the level through which the coal is loaded and the rock gangway at the top of the lift which is used as an airway and a timber haulageway. A sheet-iron chute was carried parallel with the stepped longwall face and the coal brought down to the rock chutes that connected the coal bed with the underlying gangway. This system of mining proved to be very satisfactory, and the reason it is not used at the present time is because the available coal in this bed has been exhausted.

In *Figure 18* another system of mining was tried, using rock gangways in which chutes and pillars were the form of mining. This system was not successful, but I am quite sure that if this bed had been tried on a longwall plan the results would have been much more satisfactory.

In the Beaver Hill mine, in Oregon, we were confronted about 10 years ago with a very perplexing problem. Both the top and the bottom squeezed very badly, and when I first examined the property they were using a system of chutes and pillars. Before the chutes reached the chain pillars at the top of the lift, the ground would squeeze so badly that it became necessary to begin "ripping up bottom" near the lower part of the chute in order to get the coal through to the gangway. The gangways had all been driven in coal and they, too, were giving an unusual amount of trouble, due to squeezing ground, which was breaking the timber about as rapidly as it could be placed. The cost of producing coal was prohibitive, so that a change became necessary or close the mine. Plans were then laid to drive the gangways in the rock immediately under the coal and then install a stepped longwall system, very much as illustrated in *Figure 17*. With the old chute and pillar system and with the gangway in the coal it was next to impossible to ventilate the mine so that the men were working in atmospheres that were not suited to them, and there was an enormous amount of gas that could not be removed, due to a sluggish air current. After the gangways were placed in the rock and the longwall face developed, a full current of air was forced through the gangway, up the long-

wall face to the upper rock gangways, then back to the return airway. We were able to use the squeezing ground to advantage so that practically no powder was used. The men made much greater wages; they were working in a fresh atmosphere; the gas hazard was removed and spontaneous fires in the mines reduced to a minimum. By changing the system of mining, the property was converted from an absolute failure to a positive success. We found, however, that the immediate roof caved and that we could maintain our longwall face for distances parallel with the strike of the bed of about 200 ft. But at this point the main roofs, some distance above the first roof, would act as a cantilever, with one end of the beam on the caved ground back of us and the other end on the longwall face. When this roof broke it usually smashed everything along the working face, but we knew far enough in advance when this would take place, so we could get the sheet iron out, all the men out, and these were all placed in a chute 40 or 50 ft. farther along the strike which was already prepared in anticipation of the caving.

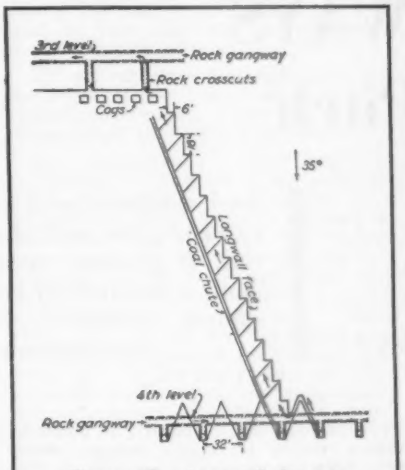


Figure 17. Longwall face in coal bed dipping 35°. Carbonado Mine

One of the difficulties we encountered in Washington that is not met with, as far as I know, in Pennsylvania mining practice, is the occurrence of "bounces" or "bumps" within certain areas, after a depth of approximately 1,800 or 2,000 ft. under cover had been reached. These "bounces" occur in the Crow Nest Pas district of British Columbia, but in that field the beds are comparatively flat. At old Black Diamond, King County, and the Carbonado, in Pierce County, Wash., the beds are dipping, and I believe that "bounces" occurring in dipping coal beds are more difficult to combat than "bounces" in flatter beds.

In Carbonado, after a "bounce" would occur in which the two walls would come together, the timbers along the gangway were shifted up the pitch, as a rule 8 or 10 ft. Any cogs that occurred up in the worked-out area were also moved, as a rule up the pitch. These "bounces" became so bad and so dangerous and expensive that it became necessary to abandon a portion of the mine in which they occurred. At Old Black Diamond, in King County, the mine workings are under a depth of approximately 2,000 ft. The McKay coal bed of that mine has a strong sandstone roof above it, and some distance above this bed was a smaller seam. In some places the "little seam," as it is called, is mined out, and where this was completely mined "bounces" did not occur within the area underlying this condition.

I have seen sections of gangways 800 or 900 ft. in length completely wrecked within a few minutes, due to a "bounce." I have seen trains of cars, several haulage locomotives, and men buried beneath large masses of sandstone that were brought down by these "bounces." In this case, again the movement seemed to be up the pitch. The chain pillar below the gangway was crushed so that what had formerly been solid coal was in a powdered condition after the "bounce."

The real cause of these "bounces" has not yet been fully determined, but my impression is that here again is a case of the immediate roofs breaking and caving within the worked-out areas and continuing to cave up for some distance above, until it reaches a strong, rigid sandstone that is strong enough to act as a beam, one end of the beam on the caved ground and the other end on the gangway and chain pillar. Finally, the caving continues until this beam weakens sufficiently so that the strata above ruptured, and in so doing produced a hammer blow within the affected area. The lines of force go vertically into the ground and are dissipated in all directions, but the damage done in the caved area we are unable to observe. The lines of force, that affect the gangways and chain pillars, are somewhat circular in motion, go down through the ground into the floor, and the pressure is great enough to cause a buckling of the floor; the pillars below are sufficiently strong, until they rupture, to cause a reaction or a deflected blow which works up the pitch and this accounts for the movement of the gangway timbers, along the gangway, up the pitch.

Miners and mine officials become accustomed to ordinary mining dangers such as falls of roof, haulage accidents, blown-out shots, burns from ignited gases, and even explosions, but it takes courage equivalent to the finest-tempered steel to stand or work within an area that is within the "bumping zone" and feel that at almost any moment, without warning, the floor beneath your feet will buckle up and the roof above your head will settle down, and about all that is left of the observer is the proverbial grease spots. Naturally, after a "bounce" takes place, it is necessary to send in the wrecking crew, immediately recover any injured and those who might be killed, then the locomotive and cars, and finally clean up the gangway for further operations. It is sometimes necessary to let that part of the mine remain idle until all trouble from "bouncing," for the time being, is arrested, and when the men are finally put to work it requires unusual courage on their part to continue with their task.

I have not attempted to discuss the mining of pitching coal in all its details, because some of the methods are so elementary that it would be a waste of your time and my time to recite such occurrences. I have attempted to discuss only some of the high lights, and in a rather sketchy manner outline to you some of the problems that confront the coal operator in the state of Washington.

Without wishing to cast reflections on the operators of any part of our great Nation or our good coal-mining friends in Canada, dozens of whom I am personally acquainted with, I do want to say a kind word for the men who are battling with the coal-mining problems of Washington, particularly the mines in King and Pierce Counties. They have real problems within those fields and, to their credit, I wish to say, are handling them very well. If some working plan can be evolved for regulating the production of oil in the United States, particularly in the state of California, the coal operators in the state of Washington will be rewarded, after many years of struggle and intelligent application to their problems.

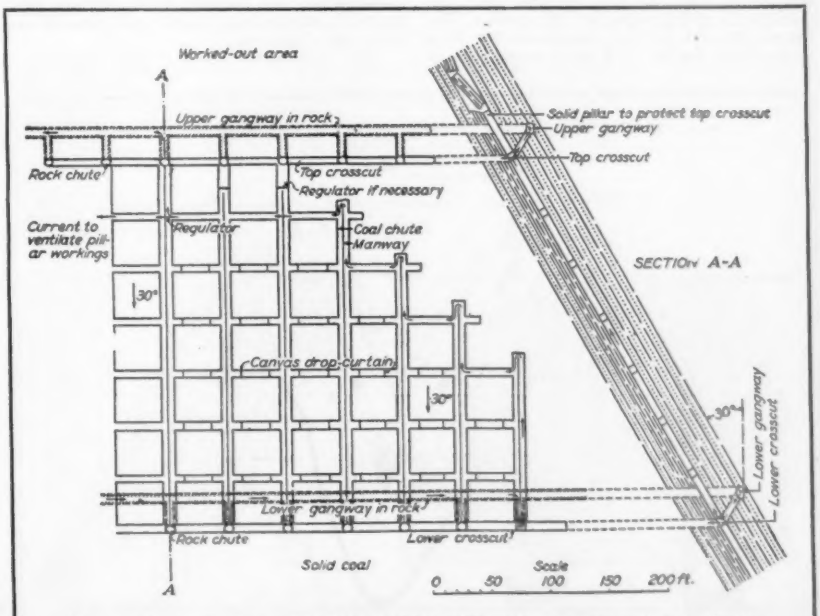


Figure 18. Ineffective method of working with rock gangway and rock chutes tried in gaseous district, Carbonado Mine

ROCK GANGWAYS under Heavy Pitch

Rock gangways used as main haulage—Recovery by this method approximates 50 percent of previous tonnage and more than doubles recovery by coal gangways—Water control established—Speed and cost of construction excellent

By E. P. HUMPHREY *

IT IS becoming more and more the practice in the anthracite field, when re-robbing large vein, to drive in the rock, under the vein or in a small leader vein, if it is present and close enough, either above or below the large vein, preferably below, and attack the large vein by means of rock holes from this gangway. If the large vein is comparatively flat and not exceeding possibly 30 degrees in pitch, the vein is mined in the vein by means of buggies and chutes from a small area tributary to a rock hole. This practice, of course, is dependent entirely upon local conditions and is not the invariable rule. With heavy pitching veins, which are more difficult and dangerous to mine in the vein, the custom quite generally is to load out the material through the rock holes until it is believed all the coal has been removed in that immediate vicinity.

Rock gangways are also being used as main haulage gangways to connect by tunnels the gangways driven in the veins when the depth below the surface makes it difficult to maintain the coal gangways, even though the coal gangways are in small virgin veins. The plan in general in this case is to drive the sectional tunnels from the rock gangway to the coal gangway, then to drive the coal gangway, mine and rob the coal between the sectional tunnels at once, in this way very often making it unnecessary to retimber the coal gangways. The length of the timbered gangway is often 500 ft. between sectional tunnels, although in many cases conditions permit them to be of longer length.

Some collieries are fortunate in having a small vein, sometimes workable, close enough to the Mammoth to permit driving in it. When this is the case, the method is to work the small vein, then tap the Mammoth by rock holes up the breast in the small vein, starting at the top and working down. The distance between rock holes and the method of mining depending on conditions.

Rather than make a rambling general survey of the rock gangway practice covering the many varying conditions in the anthracite region, this paper will be confined to "Rock Gangways Under Heavy Pitch," which is the method of mining at the Girard Colliery of the Hazle Brook Coal Company.

Before going into the subject itself, it may be interesting to trace the change in the methods of mining at this mine from the beginning, when the property was virgin, to the methods of mining and the conditions of the property at present, taking notice wherever changes were caused by the conditions, not only in the physical nature of the property but to improvements made in mining methods and mining machinery. *Figure 1* shows a typical section of this property which is approximately 6,500 ft. long. This section shows that the coal is present in 4 veins, the uppermost vein is the Primrose; it is not workable over the entire property, but where workable averaged 5 ft. in thickness; the next workable vein is known locally as the Holmes; the next under it is the Mammoth; and the lowest is the Buck Mountain.

The Holmes vein averages, over the property, approximately 8 ft. in thickness and has been entirely worked by gangways in the vein, due principally to the fact that the vein is not too thick and not far below the surface. It was possible to mine it off in sections and not require the expensive maintenance of timbered coal gangways for a long period of time. The Holmes vein at present is considered practically exhausted, and very little, if any, mining will be done in it in the future.

The Mammoth vein averages over the property approximately 30 ft. in thickness, and was entirely worked until recently by gangways in the vein. The large amount of coal recovered by rock holes from areas that have been robbed and abandoned gives evidence of the small recovery when mined by gangways in the vein.

The Buck Mountain vein averages 14 ft. in thickness and varies in character at different locations on the property. In one section of the property the entire vein was hard, requiring the mining of most of it. In another section the vein was not of as good quality, having a dirty seam at the bottom, and was very free, so it ran very easily; in fact, in this location the vein ran freely from the gangway to the surface, a distance of 600 ft.

The history of the property shows that mining was commenced in 1863, and the first coal was shipped to market in 1864. Seven different lessees have kept it in continuous operation since that time, with the exception of two years, 1887, when the Holmes slope was extended to the second level, and 1895, when the slope was abandoned, to be only partially reopened in 1903 and 1911.

The history by levels is also interesting as it clearly shows the changes of mining methods. From the beginning in 1863 to 1878, all mining was above water level, in two different levels as indicated on the section. As these areas became exhausted, the mining went deeper, improved machinery aiding principally in this development.

The first work below water level was

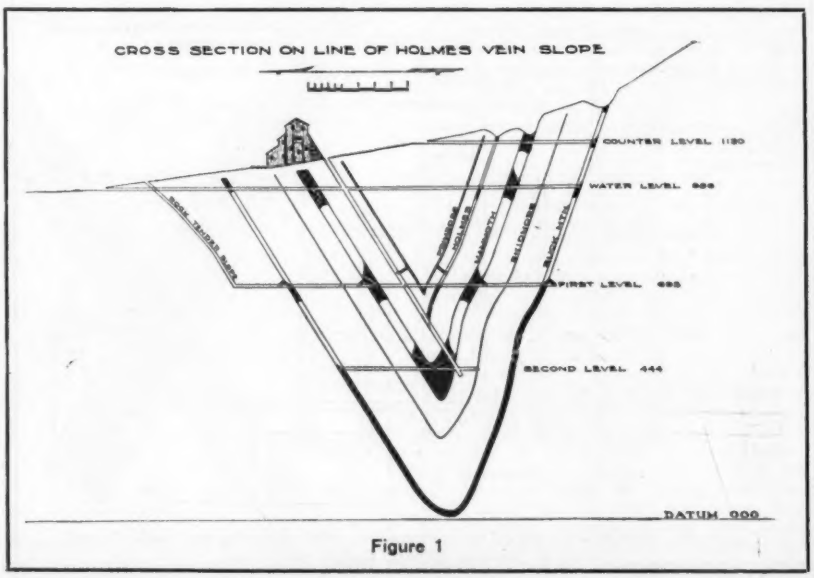


Figure 1

* General Manager, Hazle Brook Coal Company, Jeddo, Pa.

in 1877, when the slope was sunk to the new first level. Work continued on this level until 1886, when the colliery was idle while sinking to the new second level, which was finally reached at the end of 1888, and mining continued on this level until 1895. In 1896 the entire workings were allowed to fill with water, the colliery being idle from 1897 to 1902. Only the coal cleaned from the banks was shipped to market in this period. In 1903 the Holmes slope was again opened to the main water level and coal was mined from this elevation until 1911, when the mines were unwatered by use of a rock slope permitting the reopening of the Holmes slope to the old first level. Mining has since been carried on above this level until the end of 1928, when the colliery was again allowed to fill with water, the first level having been finally exhausted. The new development plans which will, it is believed, entirely mine out the property are the result of the former operating experiences, the feeling being that to economically and safely mine the remaining coal rock gangways are the only solution.

The tonnage shipped from the various levels with dates show how the depth of the mining, the character of the veins and the method affected the recovery. It is to be borne in mind that whatever may be said is not to be taken as indicating a lack of managing or engineering ability at this particular colliery, as

Period.	Level.	Method of Mining	Tonnage
1863-1877	Water level.	Gangway in vein	570,000
1878-1886	First level.	Gangway in vein	739,000
1887	Idle—sinking to second level.		
1888-1895	Second level.	Gangway in vein	659,000
1896-1903	Mine closed. Allowed to fill with water.		
1897-1902	Rewashing banks.		188,000
1903-1910	Reopening Holmes slope to water level.	Gangway in vein (Holmes vein not previously mined)	719,000
1910-1915	Reopened Holmes slope to first level.	Holmes vein, virgin, reopening others	270,000
1916-1928	First level.	Rock gangway under Mammoth and Buck Mountain, rock holes to Primrose, Holmes by coal gangway	1,455,000
		Total	4,600,000

half of the total of all tonnage removed prior to that time by coal gangways from the entire property.

The records show that mining of the Mammoth on the second level by coal gangways permitted a recovery of only 10 percent of the original vein content.

Rock gangways were first driven at this colliery in 1916, 300 ft. being driven, and as time went on coal gangways were replaced by rock gangways as fast as expedient. The only rock work driven prior to this time was the connecting tunnels, and in the early days this work was all done by hand, making it rather expensive and extremely slow. There were many reasons why rock gangways were not driven in the early days. The veins were all solid and at no great depth below the surface until the basin mining was commenced. The labor and timber was not as expensive, resulting in lower upkeep than today, furthermore rock drilling machinery and explosives have been improved to such an extent that the cost of driving a rock gangway today is only slightly more than driving and timbering of coal gangways in the solid.

Reopening of areas in the vein that have been worked over are generally more expensive than driving the rock gangways. Possibly the largest single factor for driving rock gangways is the necessity of reopening areas in robbed and abandoned veins and reworking them.

under the same conditions this is probably exactly what has happened throughout the entire anthracite region.

By the use of rock gangways there was recovered from the first level abandoned workings, in the last period, almost one-

It would be impossible in many cases to open these areas in the vein economically with the assurance of being able to keep them open to warrant continuous production and to take care of the safety of the man.

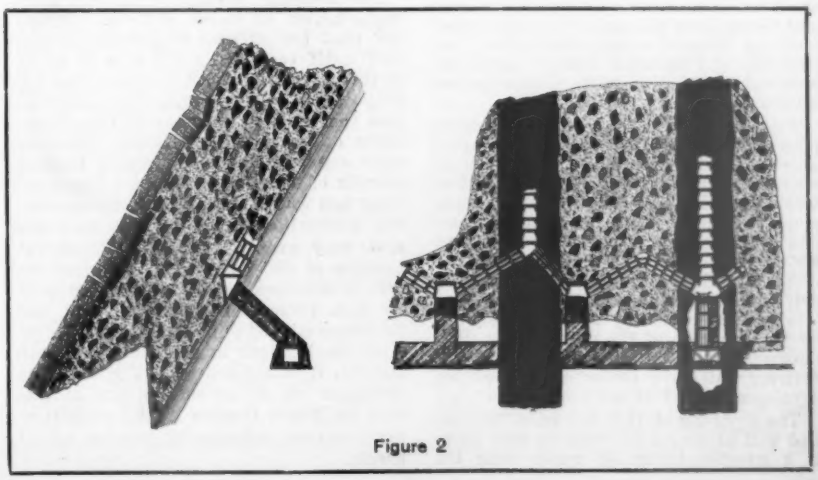


Figure 2

The average cost per yard to drive gangways through broken ground in robbed over vein areas averages $35 per yard; this, of course, depends entirely upon the nature of the material through which the gangway is being driven. Should it be necessary to relieve a set of timber, which is often the case as soon as a gangway stands for any period, or mining work has commenced above it, the cost of replacing the broken set of timber, labor only, averages from $12 to $25. The material cost for a 14-in. set of timber, including sprags and blocking, would be approximately $8. This shows that a rock gangway with rock holes will soon be cheaper than driving and maintaining a timbered gangway in the vein itself.

The manner of driving rock gangways is by contract, the contractor furnishing, in our case, the drilling machinery, explosives and all labor for drilling, blasting, blacksmithing and loading the muck in cars; the company furnishing compressed air, water, fuel for blacksmithing, transportation and disposal of the loaded rock and compensation insurance.

In some instances, for loading the muck, the contractors use loading machines, and others have apparently as much success without them. Loading machines are more often used on jobs in which speed is desired. The size of a rock gangway is 7 ft. over the rail, 11 ft. wide, with an 18-in. ditch 1 ft. below the bottom of the sills.

The rock gangways can be driven at the rate of 6 ft. per day on single shift; however, if speed is desired, more shifts can be put on, and it is possible, under ordinary conditions, to drive a rock gangway slightly faster than 300 ft. per month. The contractor receives for his work $50 to $55 per linear yard, depending on the number of faces he is driving. It is apparent the more faces driving the lower the price.

In driving rock gangways ventilation is often quite a problem. However, in driving under worked over areas, by keeping the rock holes close to the face, sufficient air will leak through the old workings to give proper ventilation. However, when this is not possible, the practice is to use tubing and portable fans. When driving under solid veins a return air heading, in the coal, is maintained while the first mining is being done and until the rock gangways are connected on both ends.

From the rock gangways to the vein rock holes are driven, generally 5 ft. high and 9 ft. wide on 35 degrees; these are also driven by the contractor and are generally spaced to suit conditions. The contract price for rock holes varies from $30 to $40 per linear yard.

Another advantage in driving a rock gangway under any large vein is that the mining and the robbing can be accomplished while the rock gangway is progressing, in that way bringing the production from that gangway to the maximum in a short time. It would be impracticable to rob in a coal gangway while it is being driven, and for that reason it means quite an outlay before the production can be brought up to maximum from that section.

At the present time, with a number of collieries in the field not working steadily, it often requires large gangs of timbermen to keep coal gangways open so that when it is time to start up the production will not be curtailed due

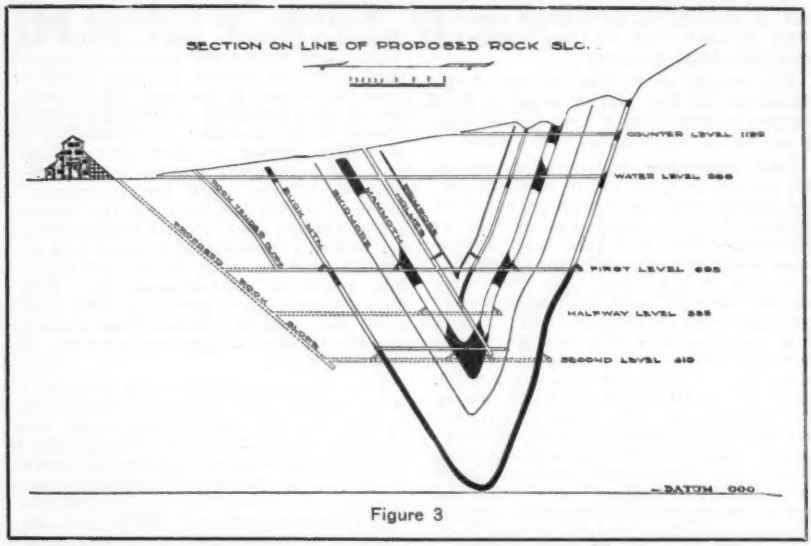


Figure 3

to the sections not being open and workable. With rock gangways this condition does not exist, and very often when the loaders return to rock holes that have been idle for some time more material has come down to the holes and the loading is improved.

The cost of coal from this system of mining, in our experience, has been found to be cheaper than the cost by any other method. The loading is done by contractors, after other contract miners have connected the rock holes by slants and broken up whatever solid coal it may be possible for them to reach. The ultimate recovery of marketable coal from the Mammoth vein, by this system of mining, has been approximately 40 percent, considering the coal that has been taken out by first mining and robbing by use of coal gangways. Had the rock gangways not been driven and these abandoned areas rerobbed, the ultimate recovery would have been approximately 20 percent. It is believed that in virgin areas, by the rock gangway method, the recovery would have been greater than the combination of the various methods.

The method of working the veins is indicated in *figure 2*. A chute is built on one side of the rock hole, permitting a manway on the other side for the loaders' use. The manway is generally built along the outside rib of the rock hole, which gives the loader a better chance to escape should he be unable to stop the flow of material and the gangway has not been connected on its inside end. At the top of the chute is a battery, on each side of which two slants have been driven, one in each direction, to couple with slants from the adjoining rock holes. Should the slant encounter a solid pillar, a chute is driven up in this pillar as far as possible for the purpose of mining this pillar. In some cases this would only be a short distance and in other cases it may go as high as 100 ft. This variance in the remaining coal conditions is the result of former mining conditions. After the slants are connected, and whatever pillar chutes possible are driven, the solid coal is blasted, the chutes and inside battery are blown, then loading commences. It is necessary, of course, to load whatever presents itself to the main battery. A car account is taken of each hole, and in many cases a fair knowledge of what to expect is at hand, so that should a lot of rock be present in the beginning it is generally loaded out with the expectation of coal being behind it. The average car yield per 100 cu. ft. is 1.75 tons.

The greatest difficulty is experienced in loading from rock holes during wet seasons. In this case the water makes the material to be loaded more active, and quite often water is dammed back of the material, which causes the chutes to get beyond control and to fill the gangways. When this condition arises, the loading is generally stopped in this section until the water is drained off. Quite often large rocks come down to the battery, requiring blasting to permit their passage through the chute. This, of course, is the same in large veins when loading out in the vein itself, particularly in robbing.

The development plan contemplates the exclusive use of rock gangways. The amount of coal to be recovered from the worked over area in the Mammoth and the remaining virgin Buck Mountain will be as much as has already been removed from the property.

It is believed that the property as it now stands would be unworkable without the use of rock gangways.

The Mammoth vein has been entirely worked over below the first level. This work was done in the period 1888 to 1896 and there is, on account of the short time and the small tonnage taken from the property during that time, a considerable amount of Mammoth coal to be won by rerobbing.

Figure 3 shows the new development plan on which work will be started shortly. This shows the new rock slope with connecting tunnels to the old first level, the new half-way level for Mammoth vein mining only, and the new second level below the old second level on which rock gangways under the Mammoth and Buck Mountain veins will be driven. The coal below the new second level will be mined by an inside slope or by an extension of the main slope. This development plan with rock gangways entirely will give better control of the development and of the output.

The pumping station will be in the rock and will be sealed by dams in case there is a greater influx of water than the pumps can handle. The pumping plant is designed to pump 8,000 gallons of water per minute to the surface.

Airways will be established from these lower levels to the surface, and on account of the network of rock gangways on the first level which will remain open, it will not be difficult to make a connection with these rock gangways and use them for returns from almost any location on the property.

The above rock gangway method has been developed to meet the conditions at Girard Colliery, and it is believed that as mining becomes deeper and old areas are reworked, the rock gangway will undoubtedly become more the established practice for the region.

END

MODERN STRIP MINING in NORTH DAKOTA

(*from page 675*)

Because of isolated situation, it is necessary that the employes at the mines live directly on or very near the properties. To meet this necessity, the company has established camps. Small but comfortable homes are furnished the employes at a nominal rental. Free fuel and ice are supplied the employes as required. Bunk houses and boarding houses are maintained for the unmarried men, while company stores supply the needs of these mining communities. The company attributes no small portion of its success to the fine spirit of cooperation found amongst its employes, and it is quite as much the duty of the management to place a turkey on each man's table at Thankskiving and to assist in filling the kiddies' stockings at Christmas as to solve the ever-present problems of battling the elements of the northwest.

No outsider visits the Dakota pits without asking about trouble encountered with snow. The question is natural, as the blizzards of the territory are legendary. Contrary to popular opinion, however, heavy snows in the lignite field are the exception rather than the rule. In the history of the field, no serious difficulty has been encountered. There are storms each year, of course, but with the protection of the waste banks, which act as very efficient snow fences, there has been little snow accumulation in the pits, other than the direct fall, which is easily scraped aside.

The company maintains its own sales organization in North Dakota. Realizing that the natural limitations of the coal itself restrict its use almost solely to the state in which it is mined, the big duty of this sales organization is to educate the trade of the state to the advantages of using its local fuel. Nice results are being obtained and a healthy growth of tonnage recorded. The company has found that lignite consumption and production in its own territory are now very evenly balanced. Rapid expansion of the business in the near future is not considered possible, but with its firm entrenchment in the field and the unquestioned opportunities for industrial development in the State of North Dakota, it is inclined to look with entire optimism on its operations and to feel that its North Dakota lignite properties form a very substantial portion of its assets.

ROCK DISPOSAL in the Anthracite Field

Problem of rock disposal accentuated by pitching seams—Breaker rock ranges from 10 to 40 percent, and development rock 10 percent of total cars hoisted—Air dump cars advantageous for final disposal—Spreaders on gob pile also aid

By J. LATIMER LEE *

IN mining anthracite it is necessary to handle certain refuse. This refuse consists of rock, slate and what is called bone, which is a cross between coal and slate, but for convenience in this article all refuse of this kind will be termed rock.

This rock is encountered, as follows:

(1) Rock from development work.

(2) Rock encountered in the actual mining at the face.

Rock from development work includes:

(a) Tunnels, rock gangways, rock holes, rock slopes and excavations for pump stations, hoist houses, etc.

(b) More or less top or bottom rock must be excavated to make the necessary room for haulageways where the veins are on a pitch since the veins in the majority of cases are not large enough so that the entire cross section of the haulageway can be driven in the coal. Also where the veins have a flat pitch but are thin, rock must be taken to make headroom.

Rock encountered at the face includes:

(a) Rock included in the vein that is interstratified with the coal, which for the anthracite region considering the beds now being worked will probably amount to about 20 percent.

(b) Top or bottom rock that may break out of its own weakness.

The rock encountered in development work is loaded into mine cars and either unloaded at come convenient point within the mine, or sent to the surface.

The rock encountered in the actual mining at the face whether rooms, breasts, or longwall faces is packed or gobbed in the mining place where the light pitch of the seam and other conditions permit. That is all of the larger pieces are so taken care of, but there are bound to be some of the smaller particles that it would be impracticable to separate and which therefore are loaded into cars with the coal. Where the pitch of the vein prohibits the gobbing of the rock in the place it must of necessity be loaded out with the coal.

Thus it will be seen that the rock which comes to the surface is in two different classes—namely, that which is in cars by itself and that which is included in the cars of coal. The rock in the first class or that which is in cars by itself has been by common use termed "Mine Rock." The rock in the cars of coal is separated from the coal in the breaker and hence has been termed "Breaker Rock."

In the northern field where flat measures predominate, the proportion of "breaker rock" will be small since a large proportion of the rock obtained in the rooms is gobbed in the mining place.

In the southern field, on the other hand, which is characterized by pitching measures, the pitch varying up to 90 degrees, there is no such opportunity of separating and of gobbing the rock, so that the proportion of rock in the cars of coal or the "breaker rock" is high.

A conservative estimate would place the proportion of "breaker rock" in the northern field at about 10 percent, while in the southern fields the "breaker rock" will range from 20 to 40 percent.

The cars of mine rock will average about 10 percent of the total number of mine cars hoisted for the whole region.

In fact on the basis of the above figures, it will be seen that the cars of coal represent only about 90 percent of the total, and of this 90 percent in the northern field, 10 percent is refuse and in the southern field approximately 30 percent is refuse. The above percentages are by volume. The percentage of rock by weight will be higher.

Some idea of the enormity of the problem of rock disposal is obtained when it is realized that for the total commercial production of the anthracite industry last year of approximately 61,000,000 tons, it was necessary to handle and dispose of over 20,000,000 tons of rock.

This is a tremendous amount and is brought more vividly to the consciousness when it is realized, that this quantity would cover an area of 17 sq. mi. to the depth of 1 ft., or that if sinking four compartment shafts, each compartment 7 x 13, making the total cross section of the shaft about 35 x 17, it would represent enough excavation to sink 528 of these shafts 1000 ft. deep. If placed on a rock bank it would build a bank one mile long, 1000 ft. wide and 90 ft. high. When it is realized that this same quantity must be disposed of on the surface each year, it will be seen that the accumulation creates a considerable problem.

In some cases the mine is situated in a thickly populated section, so that very little storage space, if any, is obtainable.

In addition to the difficulties presented by towns, buildings, streets, etc., in fact that most of the mines are located in very hilly country, and it is often necessary to lift the rock up the side hill to find suitable space for dumping.

Where surface space is lacking, some companies have aided themselves by transporting the material back into the mine and packing it into the excavations made by mining. To do this requires a crusher in the breaker to break down the large pieces, so that they may be more readily handled for back filling. This is sometimes done with a view of supporting valuable surface features and sometimes merely as a means of disposing of this rock, when no suitable place is obtainable on the surface.

Where the rock is disposed of on the surface, the method of handling must conform to local conditions.

In some cases when the mine opening is remote from the breaker, it is found advisable to dump the mine rock separately from the breaker rock saving the transportation and enabling a quicker return of the mine cars to the mine. This necessitates two dumps.

One of the most economical methods of handling this mine rock is to dump the cars into a pocket, and from there into a dump car for transportation to the rock bank. These dump cars are of different forms, which will be described later, but are designed with the purpose of carrying larger quantities and of having more efficient and satisfactory dumping facilities than the mine car.

The rock that comes up in the coal cars first must be separated from the coal. By use of screens, the large sizes are separated and passed over a picking table where the rock is picked out and sent direct to the rock pocket under the breaker. The rock in the smaller sizes is separated from the coal by mechanical means, such as jigs or other cleaning equipment of different types. This smaller rock then goes to the rock pocket to join the rock from the picking tables.

Where the mine rock has been handled separately from the breaker rock the size of the "breaker rock" is usually smaller than when mine rock and breaker rock are together, and many collieries have found it convenient and efficient to transport this breaker rock to a bank adjoining the breaker by means of a flight conveyor.

Where feasible, the mine rock and breaker rock are brought to a central point at the breaker and both are handled together. In this case the cars of mine rock are either dumped into a separate chute or are dumped into the same chute as the cars of coal, where a gate is provided, operated by hand or air, that when thrown by-passes the rock into the rock chute.

Where large quantities of rock are handled from the breaker a very good method is that of using air dump cars and handling these to the rock dump by means of a locomotive. One or more dump cars

* Special engineer, Susquehanna Collieries Co., Wilkes-Barre, Pa.

may be used per trip depending on the quantity of material to be handled.

Another efficient and convenient method of handling the rock is by electric motor larries. These are of different size according to the necessities of the situation, and vary from five tons up to larger capacities. One is known to have a capacity including the average topping of about 30 cu. yds. or nearly 35 tons.

Where lateral space is restricted it often becomes necessary to build the bank vertically. This necessitates hoisting the material with an engine and rope.

Sometimes this is done by hoisting the rock from the rock pocket in gunboats or skips, which dump into a pocket from where as before it is transported by dump cars or larries. Sometimes the larry itself is hoisted on the rope to the top of the bank from where it runs under its own power to the discharging point.

Where large quantities of rock are handled daily it is obvious that considerable labor is required on the bank to distribute the rock and lift and shift track. Two devices which save an appreciable amount of labor in this line are the spreader which pushes and spreads the material dumped at the side of the track and the track shifter a device which lifts and throws the track in either direction.

These are some of the devices which are being employed in coping with this large problem of rock disposal.

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25 to 50-FOOT STRIP MINING
(from page 675)

and at our No. 10 plant, the feeder is controlled by a variable speed transmission, which is regulated from the tipple. This flexible control keeps a uniform supply of coal to the shaker screen, and so keeps it in operation approximately eight hours a day and so assures the best preparation.

The screening sizes of strip coal is 0 by 1¼-in. slack, 1¼-in. by 3-in. nut, 0 by 3-in. nut run, 1¼-in. by 8-in. railroad coal or 8-in. mine run for railroad use, and 3-in. plus lump or an 8-in. plus fancy lump, and our tipples are equipped with crushers so these sizes can be changed when desirable. This disposal of the refuse from the picking table is quite an item, and at mines where the tonnage reaches 1,500 tons per day, it is not uncommon to produce 60 tons per day of picking table refuse. This is composed largely of pyrite with adhering coal, and it has been found practical to run this material through the breaker and recover the coal. There are present plans in the field for the erection of the first washery, where the minus 3-in. coal will be washed. I am of the opinion that the time has come when more positive preparation must be provided for the minus 3-in. coal. The washing, if a wet process, will be quite simple, in view of the fact that the principal dirt is composed of the heavy pyrite and it would be practical to make a separation at a gravity of one point eight, so reducing the washery loss to approximately 8 percent, furthermore, a separation at this gravity would reduce the ash in the minus 3-in. coal to approximately 1 percent of the adherent ash of the hand picked lump. The washery must be the answer to the preparation of the minus 3-in. coal in the Kansas-Missouri field, in consideration of the increasing demand to buy coal on a B. t. u. basis.

TAR FROM LOW TEMPERATURE CARBONIZATION OF UTAH COAL

The results of a study of heavy portions of tar from low-temperature carbonization of Utah coal made by the United States Bureau of Mines, Carnegie Institute of Technology, and the Mining and Metallurgical Advisory Boards, are given in Bulletin 41, Mining and Metallurgical Investigation, recently published by Carnegie Institute of Technology. This is the third in a series of cooperative studies of the composition of tars obtained from Mesa Verde (Utah) coal when carbonized with steam superheated to about 700° C. This investigation includes an analysis of the tars; resolution into oil, wax, and resin of the neutral portion from all three tars; a study of the composite neutral portion from all three tars as compared with crude petroleums, and the liquid hydrocarbons of this composite neutral portion and their variation with their boiling temperatures.

The authors of this study are Ralph L. Brown, former organic chemist, Bureau of Mines, and Robert N. Pollack, former research fellow, Carnegie Institute of Technology.

RECOVERY OF METALS FROM SECONDARY SOURCES IN 1928

THE value of certain non-ferrous metals recovered from secondary sources in 1928 is reported to the Bureau of Mines, as $277,623,500, which is $21,271,500 more than in 1927. This increase in total value, according to J. P. Dunlop, who compiled the figures, was due mainly to larger recoveries of copper, brass, lead, and nickel, and to the higher average price of copper in 1928, for the average prices of lead, zinc, and tin were considerably less in 1928 than in 1927. There were large gains in the quantity of secondary copper, lead, and nickel in 1928, and small increases in the quantity of secondary zinc and aluminum, and small decreases in the quantity of tin and antimony. The quantity of copper, including that in brass, increased more than 46,000 tons.

There was a continuation of the large shipments of scrap copper and brass to Europe. In 1927 the combined exports were 68,706 short tons, and in 1928, 70,146 tons. The combined imports of copper scrap and brass scrap in 1928 were about 11,400 tons, mainly from Canada and Latin American countries.

The main increase in lead was in the output of secondary pig lead at smelters which treat mainly ore. The increase at these plants was about 17,500 tons, while at regular secondary plants the increase was only about 1,500 tons. Secondary lead recovered in alloys increased 13,600 tons.

Zinc recovered by redistillation increased nearly 6,000 tons, while that recovered by sweating and remelting was about the same in 1928 as it was in 1927. The exports of zinc dross decreased 1,300 tons, but the quantity used in zinc dust, lithopone, and zinc chloride increased about 9,000 tons.

The detinning plants treated a larger quantity of clean tin plate clippings in 1928 than in 1927, but the recovery from such clippings was less. It is reasonable to assume that the efficiency of the detinning plants has not decreased in the last ten years, yet the yield of tin per long ton of tin plate clippings (according to reports filed with the Bureau of Mines) has declined from 36.27 lbs. in 1918 to 30.3 lbs. in 1928. Very few old tin coated containers were treated in 1928, for the much lower prices of tin made the handling of them unprofitable. About two-thirds of the recoveries at detinning plants were as tin content in tin tetrachloride, and tin oxide.

The profits in most lines of secondary metal recovery were larger in 1928 than for several years, and operations were on a sounder and less speculative basis. The range in metal prices was not large and secondary metal dealers and smelters relied more on ordinary profits of buying and selling.

Detailed statistics, other than those given here, may be obtained from the U. S. Bureau of Mines.

SECONDARY METALS OF CERTAIN CLASSES RECOVERED IN THE UNITED STATES, 1927-28

	1927		1928	
	Short Tons	Value	Short Tons	Value
Copper, including that in alloys other than brass	290,000	$75,980,000	325,000	$93,600,000
Brass scrap remelted	286,000	60,516,400	302,000	70,935,200
Lead as metal	119,000	34,776,000	138,000	38,797,600
Lead in alloys	157,000		170,600	
Zinc as metal	64,800	9,881,600	70,700	10,162,600
Zinc in alloys other than brass	12,400		12,500	
Tin as metal	8,800	46,302,100	8,200	35,678,300
Tin in alloys and chemical compounds	28,100		27,600	
Antimony as metal	1,700	3,060,300	745	2,451,400
Antimony in alloys	10,700		11,155	
Aluminum as metal	23,000	23,469,600	24,500	22,848,400
Aluminum in alloys	23,200		23,300	
Nickel as metal	480	2,366,000	635	3,150,000
Nickel in non-ferrous alloys and salts	2,900		3,865	
		256,352,000		277,623,500

Phelps Dodge Outlines Expansion Program

The program of expansion and development of the Phelps Dodge corporation, Morenci branch, which has been in progress for some time, was outlined early in August by Frank Ayer, manager.

At the mines the present program includes the installation of a new elevator hoist at the Joy Shaft which will now handle all supplies and men at the Humboldt Mine, doing away with the necessity of building a hoist house with its necessary hoist engine, and a vastly improved ventilation system made possible by connecting the new drainage tunnel with the fourteenth or new haulage level.

Within a short time the ore above the present undercut level, which is 24 feet above the fourth level, will be depleted, making it necessary to drop down to the ninth level and start a new undercut level on the ninth.

Work is now under way extending No. 6 hoisting shaft from the seventh level to the 1800 drain tunnel level. The shaft should be completed about December first when it is expected a new fly wheel set hoist will be installed which will handle seven-ton skips, hoisting from pockets below the 1400 level.

Under the heading of concentrator is the installation of the two new Symons cone crushers, now completed, and the starting of work on the surge bins and screens.

In the primary grinding circuit two 8½ x 12 ft. Vulcan mills have replaced one small Hardinge and one small Marcy ball mill. These mills, which are driven by 300-h.p. General Electric super-synchronous motors, are working satisfactorily. A third 8½ x 12 mill will replace another small Marcy ball mill within the next month.

At the Clifton smelter installation has been completed of an entire plant for the manufacture of copper ingots. The Clifton smelter has had excellent success in making ingots of exceedingly high purity and it is doubtful if copper is being made elsewhere with as low oxygen, sulphur, arsenic and antimony content as at this smelter.

The sales department is opening up a market for copper ingots, and the Phelps Dodge is working to the end that the entire production of the Clifton smelter will be in the form of ingot copper.

Staff Changes Announced

Changes in the official staff, which will take effect September 10, include the transfer of W. M. Sabin of Morenci, assistant manager of the Morenci branch to Bisbee, where he is to become assistant manager of the Copper Queen branch of the Phelps Dodge Corporation.

I. J. Simcox, of Clifton, superintendent of the Clifton smelter, will be elevated to the position of assistant manager of the Morenci branch, made vacant by the transfer of Mr. Sabin, and will move to Morenci with his family. The new title of his position, however, will be general superintendent of the Morenci branch.

Manganese Producers Association to Meet September 9 and 10

Reports on the condition of the manganese industry in 34 States, economic aspects of the industry, recent developments in the treatment of manganese, and the use of manganese in agriculture will be considered at the annual convention of the American Manganese Producers Association., in Washington, D. C., September 9 and 10.

According to the tentative program, former Ambassador to Germany James W. Gerard, of New York, will be chairman of the opening session at which an address of welcome will be made by J. Carson Adkerson, president of the association, followed by reports on the condition of the industry by representatives from States in which manganese occurs.

Colonel Geo. W. Steele, president of the Brunswick Terminal and Railway Securities Co., is to preside at the afternoon session when Dr. Henry C. Knight, chief of the Bureau of Chemistry of the Department of Agriculture, will speak on manganese in agriculture.

Senator Ashurst, of Arizona, is scheduled as toastmaster at a dinner in the evening at which several public men of national prominence will speak, followed by entertainment.

R. H. Brown, president of the Manhattan Electrical Supply Co., is scheduled as chairman of the morning session September 10, when recent developments in manganese treatment will be discussed. Wilson Bradley, President of the Bradley-Fitch Co., will speak on the Bradley process; Will H. Coghill, superintendent of the Rolla, Mo., Experiment Station of the Bureau of Mines, on flotation of carbonate and oxide manganese ores; and Prof. A. T. Sweet, of the Michigan College of Mines, on new processes for treating manganese.

A. J. Seligman, president of the Butte Copper and Zinc Co., is slated to be chairman of the afternoon session which will consider economic aspects of the industry, the principal speaker being Senator Oddie, of Nevada.

American Smelting & Refining Acquires New Properties

The holdings of the American Smelting and Refining Company were recently increased by the acquisition of the Estelle Mines Corporation properties at Keeler, Calif. Since its organization a little over a year ago the western mining department of the American Smelting and Refining Co., with Manager A. H. Means in charge, has started intensive development at five camps, four in Utah and one in California.

Acquisition of the Estelle group brings with it a long term lease on the adjoining Cerro Gordo, with entry and perpetual easement rights through this famous mine.

The western department of the company also recent acquired on a long term operating agreement the properties of the Tintic-Ophir Mines Co., on Lion Hill, in the Ophir district of Utah, aggregating 500 acres, and the bond and lease held by the Tintir Ophir on the Buffalo Con. group of 130 acres.

The mines included in the deal comprise some of the oldest claims in Utah.

Mining Laws of the State of Idaho

A new compilation of the mining laws of the State of Idaho, which includes revisions of laws effective May 8, this year, is just off the press and may be had without cost on application to State Mine Inspector Stewart Campbell, Boise, Idaho. This new and revised edition of the "Mining Laws of the State of Idaho" includes pertinent extracts from the United States mining laws, and notations on the latest changes in the state laws.

Mohawk Mining to Reopen Michigan Mine

The Mohawk Mining Company has started preliminary work at its Michigan mine in Ontonagon County, Michigan, preparatory to the reopening of that property. The mine has been idle since October, 1920. The equipment at "E" shaft on the Butler lode is intact, and pumping will be started as soon as the plant is overhauled.

It is planned to make an adequate exploration of the Butler lode, which has shown good values in the past, and investigate other near-by lodes as well.

At the time of closing down, Michigan was producing from "E" shaft, which was sunk to a depth of only 879 ft. The recommendation has been made that "E" shaft be sunk about 1,200 ft. more and at that depth, approximately 2,000 ft., explore the Butler lode by long drifts both east and west along the vein with an occasional crosscut at right angles to intersect the hanging wall.

The Michigan is the second of the idle properties in the Michigan copper district to reopen since the improvement in the metal market, Seneca being the first. With exception of the Carp Lake prospect, it will be the only Ontonagon property in operation. With the expected development of cheap power, however, more activity in that part of the district is likely.

Old Dominion Leads in Phelps Dodge Safety Work

The Old Dominion branch of the Phelps Dodge corporation, at Globe, Ariz., made a perfect safety record during July, when not one lost time accident was recorded in that branch out of the five Phelps Dodge branches engaged in the no-lost-time accident contest.

The order in which the units of the corporation followed the Old Dominion branch is: Morenci, two accidents; Moctezuma branch, Nacozari, Sonora, three accidents; the Copper Queen, five accidents in fourth place, and Stagg Canyon with one in fifth place.

The Morenci branch is in the lead of the safety contest for the year to date with an average of .011 based on 1,000 shifts worked and the Moctezuma is in second place with a percentage of .030 with the Old Dominion a close third with a score of .052. The Copper Queen is in fourth place with an average of .036 and the Stagg Canyon in last place with .105.

World Engineering Conference at Tokio

Two hundred and fifty American engineers and about 100 Europeans will sail for Tokio from San Francisco on October 10 aboard the President Jackson and the Korea Maru, to attend the World Engineering Congress which takes place in November. It is expected that almost every nation on earth will be represented at the Congress.

President Hoover is honorary chairman of the American committee of the congress. Mr. Sperry is chairman, and the executive secretary is Maurice Holland, director of the Division of Engineering and Industrial Research, National Research Council.

American or foreign visitors to the congress may be interested in the announcement just issued by Calvin W. Rice, secretary of the American Society of Mechanical Engineers. In a letter to Elmer A. Sperry, chairman of the American committee of the World Engineering Congress, Mr. Rice states that the society has prepared a bibliography of books on Japan in its library, 29 West 39th Street.

"This bibliography," Mr. Rice writes, "comprises eleven pages and has in turn been segregated into four divisions according to the interests of the four branches of engineering."

American Engineering Council Announces Program

Organization for 1929 of more than a score of committees to work with Congress and the Federal administration in shaping public policies involving vast engineering operations is announced by the American Engineering Council. Communications, flood control, safety of dams, water resources, and government reorganization are among the chief problems to be studied.

At a meeting of the Council's Administrative Board to be held in Washington in October these committees will submit reports reflecting the engineering attitude toward legislation arising at the next session of Congress.

Ore and Bullion Buyers' Licenses

State Mineralogist, Walter W. Bradley, announces that the amendments passed by the recent session of the legislature to the Ore and Bullion Buyer's Act became effective August 14. One of these amendments which is of particular importance to the prospector and the smaller operators in the mountain districts is that which provides for an annual license fee of only $2.00, without the necessity of a bond, for those local merchants who will purchase not to exceed a total of $1,000 in gold or silver bullion or materials per calendar year. The license fee for purchases totaling over $1,000 will be $15.00 a year, likewise without bond.

Any person or firm desiring an Ore Buyer's License should write to the State Mineralogist, Ferry Building, San Francisco, for an application blank.

Forms of Copper in Converter Slag

A study of the forms of copper in converter slag has been completed by the Southwest Experiment Station of the Bureau of Mines, Tucson, Ariz., in cooperation with the University of Arizona. The work was undertaken to get information indicative of the technical practicability or impracticability of possible mechanical methods of removing the copper from converter slag. A successful mechanical method would make possible the discarding of converter slag without

MINE PRODUCTION OF GOLD, SILVER, COPPER, LEAD AND ZINC IN UTAH IN 1928

(In terms of recovered or recoverable metal)

Advance figures by C. N. Gerry, of the United States Bureau of Mines

County	Number of producers	Ore treated	Gold	Silver	Copper	Lead	Zinc	Total value
		Short tons	Fine ounces	Fine ounces	Pounds	Pounds	Pounds	
Beaver	6	2,810	161.23	28,216	13,517	668,332	240,812	$75,237
Box Elder	3	70	.....	67	85	31,385	.....	1,871
Garfield	1	.....	10.45	.....	.....	.....	.....	216
Grand	1	.....	28.49	6	.....	.....	.....	593
Juab	21	170,477	12,902.10	2,339,009	1,747,310	19,785,802	41,563	3,036,754
Millard	1	223	.....	368	283	35,987	.....	2,343
Piute	3	6,475	3,885.38	9,443	8,494	19,273	.....	88,183
Salt Lake	33	17,253,593	141,011.72	3,762,697	287,828,061	105,103,293	44,510,260	55,374,507
San Juan	1	.....	7.06	.....	.....	.....	.....	146
Sanpete	2	13	.....	35	226	295	.....	71
Summit	9	399,082	4,575.11	3,679,405	1,470,948	41,469,235	11,917,602	5,591,034
Tooele	25	48,716	3,767.74	273,768	167,143	14,773,417	1,494,868	1,210,154
Utah	12	213,631	24,532.46	3,913,411	830,428	68,558,147	.....	6,892,431
Wasatch	5	332,021	21,659.04	3,066,421	1,168,544	41,384,855	35,652,247	6,984,967
Washington	1	6	19.01	6	.....	.....	.....	397
Total, 1928	124	18,427,117	†212,559.79	†17,072,852	293,235,039	291,830,021	93,857,352	‡79,258,964
Total, 1927	123	15,757,074	193,908.82	18,606,950	256,933,278	302,570,040	99,185,443	¶73,626,632

† Includes placer production.
‡ Average value of metals: Gold, $20.671835 per ounce; silver, $0.585 per ounce; copper, $0.144 per pound; lead, $0.058 per pound; zinc, $0.061 per pound.
¶ Average value of metals: Gold, $20.671835 per ounce; silver, $0.567 per ounce; copper, $0.131 per pound; lead, $0.063 per pound; zinc, $0.064 per pound.

returning it to the reverberatory. Some of the conclusions derived as a result of the investigation were:

In the whole slag product obtained in converting a matte containing 30 percent copper, about 10 percent of the copper in the slag is in the oxidized form; the remainder is in the form of metallic copper and sulphides. The first skimmings are low in oxidized copper, the proportion of which increases as the white metal stage approaches.

The particles of sulphide are so small in a chilled slag that they are not all freed even by grinding to pass 350 mesh.

If the molten slag is allowed to cool slowly so as to develop a crystalline structure, the size of sulphide particle is increased greatly, so that grinding to pass 150 mesh will free the sulphides almost completely. The crystalline slag is much easier to grind than chilled slag.

Cleaning of slowly-cooled crystalline converter slag by flotation is probably technically feasible.

Magma Copper to Reopen Old Workings

The management of the Magma Copper Company at Superior, Ariz., announces that development work in the bottom of the mine, which was suspended nearly two years ago, owing to a disastrous fire when several men lost their lives, will likely be resumed by January. Complete rehabilitation of the mine and the installation of concrete shafts to replace those which were formerly timbered and which have been a part of a large construction program, has been prosecuted along with ore production from upper levels. Mining operations have been bringing an average daily output of 700 tons and the smelting of 3,000,000 pounds of copper per month under the handicapped condition occasioned by fire destruction.

Inspiration Adds to Its Leaching Plant

Following calculations made by the local research staff, the Inspiration Consolidated Copper Company has started the installation of two units of a slime treating adjunct to the present $6,500,000 leaching plant, it was announced by General Manager Thomas O'Brien. The slime tank and washing plant are being erected at a cost of $650,000. The new system is expected to recover 1.8 pounds per ton from the slimes of the main leaching plant, which has a 10,000-ton daily capacity. The new system will decrease the copper content of waste slimes from 4 to 2.2 pounds per ton.

American Metal Company Buys Colorado Molybdenum Properties

The American Metal Company, Ltd., a large eastern concern, has purchased the Bon Ton molybdenum mine near Pitkin, Colo., from Thomas J. Lochrie, of Pittsburgh, Pa., and two adjoining claims from Arthur L. Pearson and W. F. McKinley, Pitkin residents. The Bon Ton is equipped with a modern milling plant, which will permit the treatment of the ore as it is mined. The sum of $45,000 was paid for the Bon Ton and $15,000 was paid for the adjoining claims. Active operations are to start at once.

Commerce Company Buys Anna Beaver Lease

The Anna Beaver mine, in the Tri-State District, has been sold to the Commerce Mining and Royalty Company. The Anna Beaver lease, consisting of 200 acres, is just south of Cardin, Okla., and adjoins the Beaver lease of the Commerce on the north. The Adams mine, in the western Oklahoma field, is not included in the deal.

The Anna Beaver mine has been one of the most productive properties in the district, with a high percentage of lead. In the past eight years the company has produced and sold more than 100,000 tons of zinc and almost 40,000 tons of lead.

Although the lease has been mined intensely for the past eight years, there is considerable uncut ground left. It is thought that the Commerce company wanted the lease mainly because it was adjacent to its Beaver lease. Harry Payne Whitney was the owner of the Anna Beaver mine.

U. S. 1928 Gold Production Totaled 2,233,251 Ounces

The Director of the Mint has announced that 2,233,251 ounces of refined gold, valued at $46,165,400, and 58,462,507 ounces of refined silver, valued at $34,200,567, were produced in the United States in the calendar year of 1928.

The figures indicated a $746,800 gain in gold production over the prior year and a reduction of 1,971,934 ounces in silver. Among the gold-producing states California led with 513,249 ounces, valued at $10,609,800, while Alaska was second with 330,604 ounces, valued at $6,834,200, and South Dakota third with 318,095 ounces, worth $6,575,600.

Utah led the silver-producing states with 17,749,317 ounces, valued at $10,383,350, while Montana was second with a production of 10,681,675 ounces, worth $6,248,780. Idaho was third in silver production, turning out 8,949,716 ounces, valued at $5,235,584. The bureau rated the silver at the average New York price of bar silver of 58½ cents per ounce.

Pamphlet Contains Arizona Mining Laws

Tom C. Foster, state mine inspector of Arizona, has issued a pamphlet containing the revised mining laws of that state, including changes made by the legislature last winter, most of which became effective July 1. This is the first time in several years that Arizona mining laws have been available in compact form.

Mine Production of Gold, Silver, Copper, Lead and Zinc in Montana in 1928

(In terms of recovered or recoverable metal)

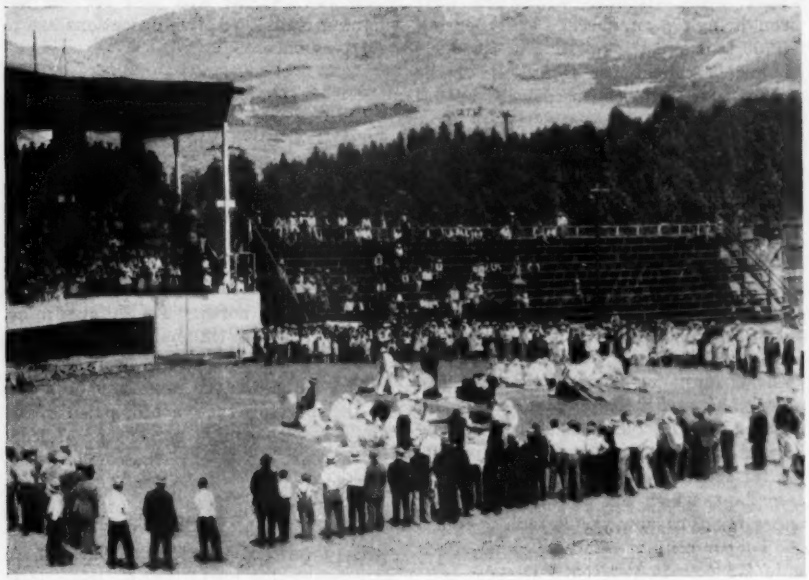
Advance figures by C. N. Gerry, of the United States Bureau of Mines, Department of Commerce

County	Number of producers	Ore treated Short tons	Gold * Fine ounces	Silver * Fine ounces	Copper Pounds	Lead Pounds	Zinc Pounds	Total value
Beaverhead	11	1,432	91.19	45,889	54,813	599,802	108,772	$78,047
Broadwater	20	8,090	973.45	44,818	12,021	1,552,697	9,168	138,688
Cascade	8	199,945	355.99	512,440	768,971	2,863,135	766,826	630,706
Deer Lodge	4	488	401.75	3,233	363	.....	.....	10,248
Fergus	3	65	95.44	1,701	.....	.....	.....	2,968
Flathead	1	585	8.03	59,631	.....	.....	.....	35,050
Granite	23	49,843	1,165.16	381,782	64,852	683,423	2,548,695	451,877
Jefferson	39	9,162	1,030.19	73,851	67,414	796,178	1,025,482	182,882
Judith Basin	6	5,633	30.72	31,809	8,329	540,000	347,278	72,946
Lewis & Clark	27	130,558	12,257.89	71,592	6,081	990,325	12,752,256	1,131,477
Lincoln	7	1,460	731.38	3,504	290	99,815	36,843	25,248
Madison	49	38,754	11,315.59	54,663	210,036	880,375	11,175	347,881
Meagher	1	39	.....	74	271	1,334	20,399	1,403
Mineral	9	393	103.81	5,550	532	72,884	135,127	17,940
Missoula	2	15	2.76	682	97	1,765	2,135	702
Park	1	1	4.26	.....	.....	.....	.....	88
Phillips	5	1,549	223.40	740	.....	122	.....	5,058
Powell	18	182	534.01	1,722	41	4,000	.....	12,284
Ravalli	1	.....	1.79	.....	.....	.....	.....	37
Sanders	1	37	.....	976	954	14,504	.....	1,549
Silver Bow	43	3,896,048	28,869.28	9,558,619	247,056,962	24,660,285	147,896,033	52,218,170
Total, 1928	279	4,344,279	58,196.09	10,853,276	248,262,027	33,759,644	165,660,189	†55,365,249
Total, 1927	307	4,222,607	53,541.25	11,200,077	223,492,639	35,898,315	160,461,803	‡49,265,925

* Includes placer production.

† Average value of metals: Gold, $20.671835 per ounce; silver, $0.585 per ounce; copper, $0.144 per pound; lead, $0.058 per pound; zinc, $0.061 per pound.

‡ Average value of metals: Gold, $20.671835 per ounce; silver, $0.567 per ounce; copper, $0.131 per pound; lead, $0.063 per pound; zinc, $0.064 per pound.



A view of the first aid teams in action and part of the crowd.

BUTTE CELEBRATES SAFETY DAY

THE largest crowd that ever assembled for a Butte Miners' Safety First Field Day and the finest program yet presented marked the twelfth annual celebration of this event at Butte, Mont., July 29. All mining activity in the district was suspended for a 24-hour period, thus giving all employes, except watchmen and pumpmen, an opportunity to attend. Official estimates indicate that well over 25,000 persons visited Columbia Gardens, the scene of the events, during the day.

The Leonard first aid team is now the champion of Montana, defeating last year's international champions, the Great Falls zinc mill team, by a fraction of a point to win first place and the J. R. Hobbins trophy.

The six teams entered were the concentrator team and the foundry team from Anaconda, the Emma and Leonard from Butte and the furnace refinery and the zinc plant from Great Falls.

They finished in the following order: First, Leonard, 485 points; second, Great Falls, zinc mill, 484; third, Emma, 478; fourth, foundry, Anaconda, 474; fifth, furnace refinery, Great Falls, 470; sixth, concentrator, Anaconda, 457.

Three problems were worked out in the morning and two in the afternoon to determine the winner.

The Leonard is now three times champion of Montana, having previously won in 1925 and 1926. It likewise has two "legs" on the Bauer & Black cup. One more win, and the Bauer & Black cup will become the property of the team.

The team will represent Montana at the national meet to be held in Kansas City in September.

Against the largest list of entrants thus far recorded in a mucking contest in the Butte district, John Espeland, from the Steward mine, who won the championship in 1925 and 1926 and captured second place in 1921 and 1928, again won first honors in this event.

Espeland's time was 1:46 1-5. This was 1 1-6 slower than his time last year, when he was runner-up to William Vitti, who has a record of 1:44. The test was 1,000 pounds of oiled lime rock.

Other events on the day's program included various athletic and novelty contests for boys and girls, athletic contests for miners, a doll parade, baseball game, soccer football game, a horseshoe pitching contest, a pet exhibition for children under 17 years of age, and dancing in the evening.

The Leonard Mine Team of the Anaconda Copper Mining Company, winners of the Montana State first aid championship. Back row, left to right—M. P. Kelly, safety engineer at Leonard; Joe Hoff, Maurice Berry, Homer Hagen, foreman of the Leonard Mine; Cecil Hastie, James Lawrence and W. B. Daly, superintendent of mines for Anaconda. Front row—Phil Trythall, captain; Guy Osello, instructor; and Roland Herzog.

The Butte Miners' Safety First Field Day is an annual picnic, sponsored by the Anaconda Copper Mining Company, Butte & Superior Mining Company, East Butte Copper Mining Company and the North Butte Mining Company, having for its purpose to give mine employes and their families an opportunity to meet and get acquainted, have a pleasant holiday and to advertise safety and first aid. The first of these picnics was held in 1918 and annually since, the present one being the twelfth consecutive year the celebration has been held. Attendance at these gatherings has varied from 15,000 to 22,000 until this year, when well over 25,000 people attended.

The first aid contest determines which of the teams representing the mines at Butte and plants at Anaconda and Great Falls, shall represent the Montana operations of the Anaconda Copper Mining Company in the international contest. The cost of this trip, varying from $2,000 to $3,000, makes this an outstanding feature.

The teams participating in the contest were selected as a result of an elimination contest held earlier in the season.

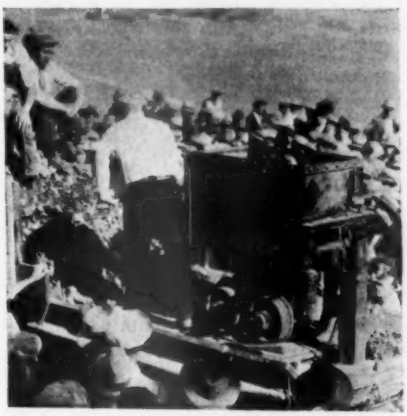
The Butte teams were winners of first and second place in a contest in which 15 teams engaged, held during the second week in May. The two Great Falls teams were winners of an elimination contest held at Great Falls, in which 23 teams took part, on June 22, and the two from Anaconda being winners in an elimination contest at Anaconda, held on June 24, from a field of 24 teams, so that the contest on Field Day really represents 62 teams of 6 men each, or 366 contestants participating in this first aid contest.

The preliminary elimination contests were judged entirely by local men, while

This young lady took first honors in the doll parade, one of the features of Safety Day.

the contest on Field Day was judged by employes of the Bureau of Mines, each having a local judge assisting, and thus placing two judges on each team.

The mucking contest is distinctly a Butte feature and was devised to replace the old hand steel drilling contest of former miners' celebrations. In this contest a small platform scales is set up in the back end of a large auto truck, a platform is built in the bottom of the truck, flush with the top of the scales platform. This platform is covered with a turnsheet and washed limestone is dumped into the front end of the truck. A regular mine car is then placed on the platform of the scales. The tare of the



One of the contestants in the mucking contest

car is then set off on the scale beam, and a 1,000 pound weight added. The contestant then shovels the limerock into the car until the scale beam rises. Judges, with a stop watch, note the exact time required to place 1,000 pounds of rock into the car.

The field day is usually held the latter part of July, when the weather is almost certain to be good. Columbia Gardens is a pleasure resort situated about 2½ miles northeast of the city, in a canyon on the western slope of the Continental Divide. The equipment consists of an athletic field, grandstand and bleachers, largest dancing pavilion in the state, merry-go-round, roller-coaster, and all manner of other playground equipment.

In addition to the prizes for the athletic events, the committee in charged served 1,300 gallons of free lemonade, gave away to the children 3,000 toy ballons and 2,000 souvenir fans to the lady guests.

The general committee in charge of the meet was composed of the following: R. F. Minister, chairman; J. A. O'Neil, vice chairman; W. H. Meyers, secretary; W. H. Statts, treasurer; Angus McLeod, J. N. Hosking, O. A. Dingman, W. J. McMahon, Ben Hardin, J. E. Watson, J. P. Carroll, J. W. Kelly, Hugh Quinn, Clyde Potter, L. Manion, Stephen Hurley, W. D. Griffith, J. M. Mattson, Dr. A. L. Murray, R. G. Makinson, M. P. Kelly, James H. White, John L. Boardman, chairman Anaconda Copper's Safety Bureau; William J. Ryan, Wm. Murphy, J. W. Warren, Len Harrington.

Phelps Dodge Discontinuing Shovel Operations at Sacramento

According to an announcement by Capt. J. P. Hodgson, general manager of the Copper Queen branch of the Phelps Dodge Corporation, steam shovel operations in the Sacramento pit at Bisbee are being discontinued and the remainder of the ore in the pit will be removed by underground operations. For this work it has been necessary to drive a new level at the 500-ft. depth in the Sacramento shaft. Aside from the pit ore, a block lying to the north of the shart, which is part of the east orebody, is being developed from this level and prepared for block caving. These operations, according to Capt. Hodgson's announcement, together with the present caving work in the 850 southeast extension, will provide ore for the company's mill below Warren for some years to come.

Eaton Leaves for Africa

Lucien Eaton, Ishpeming, Mich., district superintendent of mines of the Cleveland-Cliffs Iron Co., has left for northern Rhodesia in Africa. Mr. Eaton is going on leave of absence in the year. He will make inspection and recommendations of methods to be employed at the copper mining properties of Roan Antelope Copper Mines, Ltd.

Continental Chief Mine, at Leadville, To Reopen Soon

First shipment of lead and silver ore from the old Continental Chief mine since the early '80s, when over $3,500,000 were taken out, will likely be made within the next two months, F. R. Wolfle, president and manager of the Continental Chief Mining Company, stated recently.

Some high-grade silver ore assaying 125 ounces to the ton has been encountered in one of the new lateral drifts, and ore running 30 percent lead also has been found. There is also considerable lower grade ore which will pay to haul to the local smelter, according to Wolfle.

Tri-State Holdings of Lawyers Mining Company Sold to Childress

Frank Childress and associates on August 1 purchased the Tri-State holdings of the Lawyers Mining Company for a consideration of $350,000. The Mid-Continent Lead and Zinc Corporation has been formed to take over the property.

The holdings of the Lawyers company consisted of a 90-acre lease in the western Kansas field, equipped with two mills, and a 160-acre lease known as the Karcher lease, located in the northwest extension.

Only the No. 2 mill has been in operation the last year. It was closed August 1 and was scheduled to go into operation September 1, following improvements to the property.

Extraction of Potash from Wyoming Leucite

As part of a general program concerning the extraction of potash from a variety of raw materials, such as Texas polyhalite and New Jersey greensands, the Nonmetallic Minerals Experiment Station of the Bureau of Mines, in cooperation with Rutgers University at New Brunswick, N. J., has started some research on the extraction of potash from Wyoming leucite. This material is a potash-bearing silicate which is readily attacked by acids, which dissolve the potash and alumina leaving a siliceous skeleton of the original mineral. Another process depends upon the digestion of leucite with alkalies under pressure.

An economic analysis of various proposed methods for the extraction of potash from leucite has been started. From the cost of the raw materials required, and the estimated return from the sale of the products, the maximum amount of money available for treatment, overhead, freight, profit, etc., is being determined. In this manner, a few of the more favorable processes are being selected for chemical engineering studies.

SENATE FINANCE COMMITTEE REPORTS TARIFF REVISION MEASURE

Bill reported by Senate Finance Committee—Debate on measure begins September 5—Unless bill is passed by Senate before January 1 leaders plan to postpone its further consideration for another year to keep the measure out of the political campaign of 1930.

Many changes were made by the Senate Finance Committee in the rate provisions of the tariff bill as passed by the House. While domestic producers of pig iron requested a duty of $3 per ton, the Senate committee gave them half that amount, which, however, was an increase over the $1.12½ per ton duty allowed by the House. The duty on spiegeleisen was advanced from 75 cents to $1 per ton, and a new duty of $2 per ton was allowed on granular or sponge iron. The 75 cents per ton duty on scrap iron and steel was enlarged to include hammer, roll, and mill scale products. The duty on the molybdenum content of iron and steel was decreased from 4 to 3 cents per pound, while the duty on its chromium content was increased from two-tenths to three-tenths of 1 percent.

Manganese

Two votes were taken in committee on the manganese duty before the issue was finally settled. This duty was one of the most bitterly fought, and the committee action resulted in a victory for its opponents. The committee first decided by a vote of 7 to 4 to retain the existing duty of 1 cent per pound, and to apply it to ores of a manganese content as low as 10 percent. Subsequently, by a vote of 6 to 5, the Republican members of the committee, who controlled the rewriting of the measure, decided to place manganese ore and concentrates on the free list. The duty on tungsten ore or concentrates was reduced from 50 to 45 cents per pound; that on ferromanganese, manganese metal, manganese silicon, and boron from 1⅞ cents to 65/100 of 1 cent per pound. The duty of 60 cents per pound and 25 percent ad valorem on ferrotungsten was amended to include tungsten carbide powder. The silicon aluminum section was amended to provide a duty of 3½ cents per pound on silicon aluminum and aluminum silicon and a duty of 25 percent on ferrosilicon aluminum and ferroaluminum silicon instead of the 5 cents per pound duty provided by the House. The duty on ferrochrome was cut from 3½ to 2½ cents per pound on the product containing 3 percent or more of carbon, and from 30 to 25 percent on the product containing less than that amount of carbon. The duty on barium was enlarged to include tantalum. The tariff on cerium metal was cut from $2 to $1 per pound, and the duty on ferrocerium and other alloys was likewise cut in half, but the additional 25 percent ad valorem rate was retained. The duty on ductile tantalum metal was amended to include ductile columbium or niobium metal and tantalum metal. The duty on bars, blooms, etc., was changed to 3/10 of 1 cent per pound on those valued not above 1½ cents per pound, as compared with the House rate of 2/10 of 1 cent per pound on those valued at not over 1 cent per pound. The provision in the House bill for a duty of 2/10 of 1 cent per pound on steel ingots valued at not over 1 cent per pound was eliminated and a duty of 1½ cents per pound substituted. Paragraph 305 was amended to provide additional duties on all steel or iron in the preceding sections. The 8 percent additional duty was enlarged to apply to tungsten or molybdenum or more than 3/10 of 1 percent of chromium. The additional duty on chromium was reduced from 4 to 3 cents per pound on the chromium content in excess of 3/10 of 1 percent instead of 2/10 under the House bill. A new paragraph was provided for the deduction from duty in these paragraphs on steel, of an amount equal to 87 ten thousands of 1 cent for each pound.

Antimony Duty

In place of the House duty of 2 cents per pound on antimony as regulus or metal, the committee provides a sliding scale as recommended by H. P. Henderson, mining engineer of New York, except as to the rates. This sliding scale will apply to antimony of whatever grade as follows: Four cents per pound, if the price is not over 7 cents per pound; 3½ cents per pound, if the price is over 7 cents and not over 8 cents per pound; 3 cents per pound, if the price is over 8 cents and not over 9 cents per pound; 2½ cents per pound, if the price is over 9 cents and not over 10 cents per pound; 2 cents per pound, if the price is over 10 cents and not over 11 cents per pound; 1½ cents per pound, if the price is over 11 cents and not over 12 cents per pound; 1 cent per pound, if the price is over 12 cents and not over 13 cents per pound; ½ cent per pound, if the price is over 13 cents and not over 14 cents per pound; if the price is over 14 cents per pound,

MINE PRODUCTION OF SILVER, COPPER, LEAD AND ZINC IN THE CENTRAL STATES IN 1928, BY STATES

State	Silver		Copper	
	Fine ounces	Value	Pounds	Value
Illinois	3,146	$1,840	.....	.....
Michigan	17,153	10,035	178,442,704	$25,695,749
Missouri	176,840	103,451	65,000	9,360
1928	197,139	115,326	178,507,704	25,705,109
1927	332,642	188,608	177,988,775	23,316,530

State	Lead		Zinc		
	Short tons	Value	Short tons	Value	Total value
Arkansas	38	$4,408	86	$10,492	$14,900
Illinois	385	44,660	17	2,074	48,574
Kansas	25,276	2,932,016	107,251	13,084,622	16,016,638
Kentucky	39	4,524	92	11,224	15,748
Michigan	.....	.....	.....	.....	25,705,784
Missouri	195,393	22,665,588	12,974	1,582,828	24,361,227
Oklahoma	43,687	5,067,692	180,252	21,990,744	27,058,436
Wisconsin	1,698	196,968	18,417	2,246,874	2,443,842
1928	266,516	30,915,856	319,080	38,928,858	95,665,149
1927	280,445	35,336,070	369,125	47,248,000	106,089,208

Value computed at the following average prices for 1928: Silver, $0.585 per ounce; copper, $0.144 per pound; lead, $0.058 per pound; zinc, $0.061 per pound.

such antimony shall be exempt from duty.

For the purposes of the paragraph, "price" is defined to mean the wholesale price (averaged for a period of one week) of ordinary brands (whether domestic or imported) in the New York market as shown by the last quotation (given in a recognized weekly trade journal to be designated from time to time by the Secretary of the Treasury) prior to the date of arrival of the imported antimony in the United States.

The committee continues the present rate of ¼ of 1 cent per pound on needle or liquidated antimony.

Lead Rates

The lead ore rate of 1½ cents per pound is retained and the bond provision is applied to the ores, flue dust and mattes. The committee strikes out the House section providing that the zinc duty shall not be applied to the zinc contained in lead or copper ores unless actually recovered. Zinc dross and skimmings are eliminated from the 1½ cents per pound duty. The duty on hand tools is increased from 50 to 60 percent, while there is a reduction from 50 to 45 percent in the duty on iron and steel articles not especially provided for if composed of iron, steel, lead, copper, brass, nickel, pewter, zinc, aluminum or other metal.

The duty on calcium carbide in the chemical schedule is reduced from 1 to ½ cent per pound. A new duty of 6 cents per pound is provided for iron ammonium oxalate and iron sodium oxalate.

Earthenware Schedule

Under the earthenware schedule, the duty on crude magnesite is changed from 5/16 to 15/32 of 1 cent per pound. The duty on plaster rock or gypsum, ground or calcined, is increased from $1.40 to $3 per ton. The duty on unmanufactured pumice stone valued at $15 or less per ton is changed from 1/10 to 1/20 of 1 cent per pound; that valued at more than $15 per ton from ¼ to ⅛ of 1 cent per pound; wholly or partly manufactured, from 55/100 to ¾ of 1 cent per pound. The duty on china clay or kaolin is reduced from $2.50 to $1.50 per ton; that on crude feldspar from $1.50 to $1 per ton. A new duty of $5 per ton is provided on earths artificially activated with acid or other material. Duties of $4 per ton on crude silica and $7.50 per ton on silica suitable for use as a pigment are eliminated. Cut or trimmed mica is given a duty of 35 percent and the duty on mica splittings is reduced from 30 to 25 percent. The duty on waste, scrap and ground mica is reduced from 20 to 5 percent. The 25 percent duty on talc is retained, but the duty of ⅜ of 1 cent per pound is eliminated. The duty on amorphous graphite is cut from 10 to 5 percent, and that on chip or dust graphite from 25 to 20 percent. The duty on travertine stone is cut from 25 to 15 cents per cu. ft.

In the sundries schedule, garnet is included in the emery paragraph, and it is provided that if these products and other artificial abrasives contain more than one-tenth of 1 percent of vanadium, more than 2/10 of 1 percent of tungsten, molybdenum, etc., or more than 3/10 of 1 percent of cronium, the duty shall be 60 percent.

Copper and Silver

Under the free list section, antimony ore is retained as is also arsenious acid or white arsenic. Calcium arsenate is also continued free of duty, as is cerite or cerium ore, chromite or chrome ore, coal of all kind, coke, cobalt and cobalt ore, coins of gold, silver, copper or other metal, composition metal of which copper is the principal material, copper, and copper sulphate. The present free provision regarding metallic mineral substances in a crude state and unwrought metals is changed to provide for the free entry of metallic mineral substances in a crude state, such as drosses, skimmings, residues, brass foundry ash and flue dust not specially provided for. The cyanide provision is amended to include the free entry of nitroprussides, ferrocyanides, ferricyanides and cyanates. The emery ore provision is amended to include the free entry of crude artificial abrasives not specially provided for. Crude and refined petroleum is also continued free and the free duty provision on gold ore is applied to nickel oxide. The committee declined to impose a duty on silver. Plaster rock or gypsum in the crude state is continued free. The sodium free duty section is amended to include crude or refined nitrate and crude salt cake. The provision for free entry of tin in bars is amended to include alloys in chief value of tin not specially provided for. The free duty provision for witherite amended to cover the crude, unground product.

Bill Has Rough Going

The tariff revision bill, which began its course in Congress on January 7 last, when the House Committee on Ways and Means began hearings on the measure, is having a rough and rocky road to travel through the various legislative stages. The House did not receive the new bill from its Ways and Means Committee until early in May, and it was late in that month before it was passed by that body. Beginning June 10, the Senate Finance Committee began hearings on the measure, which were not concluded until early in August. On August 19 the Republican members of the Senate Finance Committee completed and announced the rate provisions of the measure, but it was not until late in August that its administrative features were finished. The committee plans to report the bill to the Senate on September 4 and to begin its consideration the day following. Leaders plan to keep the measure before the Senate to the exclusion of all other business until it is finally passed. In order to prevent the measure from becoming involved in the political campaign in 1930, when a new House of Representatives and 32 Senators are to be elected, Senate leaders have intimated that unless the tariff bill is passed by the Senate by next January 1, the measure will be deferred for another year. Senate leaders do not plan extensive speeches in explanation of the bill, but have decided to begin consideration of the amendments to the House bill at once in order to expedite its consideration. Although the Senate in June defeated a resolution by Senator Borah, Republican, Idaho, to confine the tariff revision to agricultural and related products, effort will be renewed in September by Democratic Senators, headed by Senator Thomas, Democrat, Oklahoma, to confine the revision to those articles. The Senate reconvened on August 19, after its recess which began June 19, but met only on Mondays and Thursdays until September 4, because the tariff bill was not ready for its consideration. The House will reconvene September 23, but will transact no business until October 14, meeting only twice a week, while waiting on the Senate for the tariff bill and its conference committee consideration after the Senate disposes of the measure. After October 14, however, the House will dispose of miscellaneous business, but the general legislative program will not be commenced until the regular session of Congress, beginning December 2.

BOOK REVIEW

"Sedimentary Kaolins of Georgia," by Richard W. Smith; published by the Geological Survey of Georgia.

This volume of 482 pages is the largest and most complete of the clay publications of the state.

The first 60 pages are devoted to a history of the clay industry; the properties of clays; their geology, origin, and classifications; and their uses.

The balance of the book is a detailed description of their distribution by counties, together with many illustrations, analyses, and laboratory tests.

The entire volume concludes with a complete bibliography of the kaolins and bauxites of Georgia, and with the usual complete engineering index characteristic of the publications of the Georgia survey.

COAL PRODUCTION REPORTS ISSUED

KENTUCKY

Kentucky retained its place as the third largest bituminous coal producing state in the country in 1928, according to the Bureau of Mines. Total production for the year amounted to 61,860,379 net tons, of which 45,583,163 tons was accounted for by eastern Kentucky and 16,277,216 tons by western Kentucky. In comparison with the 69,123,998 tons produced in the preceding year, the output for 1928 shows a decrease of 10.5 percent. Harlan County, the principal producing county in the state, however, shows a substantial gain in production, increasing its output from 13,667,443 tons in 1927 to 14,427,444 tons in 1928.

As was evident in other important coal-producing states in 1928, the general tendency in Kentucky has been toward the concentration of output in the larger and more efficient producing units. The number of active mines of commercial size was reduced by nearly 100 in 1928, while a corresponding reduction is shown in the number of men employed in the mines. There was, however, an encouraging increase in the output per man-day, the average for 1928 being 4.69 tons as against 4.50 tons in 1927.

The total value of the coal produced by the mines of Kentucky in 1928 was $96,722,000; of this $76,630,000 was contributed by the mines of eastern Kentucky and $20,092,000 by the mines of western Kentucky. In comparison with the previous year, the total value of the coal produced shows a decrease of 18.9 percent. The average price f. o. b. mines in 1928 was $1.56 a ton, 17 cents less than in 1927.

ALARAMA

The total value of the coal produced in Alabama during 1928 amounted to $39,601,000. Jefferson County alone accounted for $19,946,000 of this amount, or 50.4 percent. Another 24.2 percent was accounted for by Walker County, which ranked second to Jefferson in coal production. The remaining 25 percent was distributed among Bibb, Shelby, Tuscaloosa and several counties of lesser importance.

In comparison with the preceding year, the coal production of Alabama shows a decrease of 10.8 percent, the total output in 1928 being 17,621,362 net tons as against 19,765,866 tons in 1927. All of the principal producing counties shared in this decrease, but the output of Fayette and Marion counties showed a distinct increase over that of the previous year.

There were 25,708 men employed in the coal mining industry of the state in 1928, of whom 21,850 worked under ground and 3,958 were surface workers. The total number of men employed in the mines in 1927 was 27,615. The average number of days worked in 1928 was 222 as against 231 days the year before.

TENNESSEE

Production of coal in Tennessee during 1928 amounted to 5,610,959 net tons. The total value of the coal produced by the mines of the state was $9,694,000, or $1.73 per ton. In comparison with the year preceding, the total value shows a decrease of 8.9 percent and the total tonnage a decrease of 3.0 percent, reflecting the lessened activity that characterized the coal industry throughout the country during 1928.

Campbell County continued to lead all other counties in the state in the production of coal with an output of 1,067,271 tons. Claiborne and Anderson counties ranked next in importance, producing 985,265 tons and 963,405 tons respectively. Each of these leading counties shows a slight drop in production when compared with 1927.

In 1928 there were 7,849 men employed in the coal mines of Tennessee, of whom 6,699 worked underground and 1,150 on the surface. The total number of workers employed in coal mining the year before was 7,691. The average number of days worked in 1928 was 226 as against 235 days in 1927 and the output per man per day declined from 3.20 tons to 3.16.

MISSOURI

Missouri is one of the few states which shows an increase in the production of coal in 1928. The total production last year was 3,732,421 net tons as compared with 3,064,343 tons in 1927, an increase of nearly 22 per cent. Barton County alone accounted for 234,231 tons of this increase. Other important gains are shown for Lafayette, Henry, Ray, and Macon Counties.

In spite of the increase in production, fewer men were employed in the coal mines of Missouri in 1928 than in the previous year. Those remaining in the industry, however, were given steadier employment. The total number at work declined from 6,232 in 1927 to 5,964 in 1928, but the average time worked by the mines increased from 151 days to 180 days. The figures for 1928 also show an encouraging increase in the output per man day, the average last year being 3.47 tons as against 3.26 tons in 1927.

In comparison with 1927 the total value of the coal produced shows an increase of 10.8 per cent, the total value in 1928 being $9,637,000 as against $8,698,000 in the year preceding. The average price declined from $2.84 per ton in 1927 to $2.58 per ton in 1928.

MONTANA

Coal production in Montana in 1928 amounted to 3,324,195 net tons, the largest quantity produced since 1920. In comparison with the output in the preceding year, the production in 1928 shows an increase of 5.7 per cent. This increase, however, was largely accounted for by Rosebud County, where the development of stripping operations has caused production to mount rapidly.

In spite of this substantial gain in production, fewer men were employed in the coal mines of Montana in 1928 than in the previous year. This is largely explained by the increasing proportion of the State's production coming from strip pits where the output per man-day is very much greater than in the deep mines; but it is also due in part to the installation of loading machines which tend to increase output per man employed. The total number of men employed in the coal mines of the State in 1928 was 2,191, as against 2,281 men the year before. The average output per man per day increased from 6.99 tons in 1927 to 7.93 tons in 1928.

The total value of the coal produced by the mines of the State in 1928 was $7,550,000, as compared with $7,403,000 in 1927. The average price f.o.b. mines was $2.27 per ton, as against $2.35 per ton in the preceding year.

First Annual Kanawha Valley Safety Meet is Big Success

Finishing with a percentage 1/800 less than perfect, the No. 1 team of the Kingston Pocahontas Coal Company carried away first honors in the first annual Kanawha Valley safety meet held at Montgomery, W. Va., August 3. The team scored 799 points out of a possible 800, and received for its efficiency in first-aid work a silver loving cup presented by the National Coal Association, and a silver cup donated by the Mine Safety Appliances Company. A gold watch was also presented to each member of the winning team by the Kanawha Valley Mining Institute.

Thirty-five teams participated, and the event was witnessed by 10,000 persons. Second honors went to the Ansted team, from the Gauley Mountain Coal Company, with a score of 797 points. The other ranking teams were from the mines of the Carbon Fuel Company, Elk River Coal & Lumber Company, Wyatt Coal Company, Cannelton Coal Company, Kelly's Creek Colliery Company, and Loup Creek Colliery Company, finishing in the order named. R. M. Lambie, chief of the State Department of Mines, awarded the prizes to the first seven teams.

Safety Methods Are Lessening Mine Accidents in Pennsylvania

The annual toll from mine accidents has been reduced by safety methods inaugurated in both anthracite and bituminous mining sections of the state, Walter H. Glasgow, secretary of the State Mining Department, says in his biennial report filed with Governor John S. Fisher.

One of the systems adopted under Secretary Glasgow was to take up with the responsible mine official each individual fatality where the investigation of the mine inspector showed any evidence of carelessness, lack of discipline, or failure to comply with the state mining laws or safety regulations in effect at the mine.

As an added precaution, the report states, in the anthracite mining operations the Department of Mines has urged constantly the use of batteries for firing shots. While two years ago that method was seldom used, at the present time more than 50 percent of all blasting is done by electric batteries.

In the bituminous region the department has been active in urging rock dusting of all gaseous mines to prevent explosions. During the past two years 40 additional mines were rock dusted, bringing the total up to 144. The program, Secretary Glasgow said, is being rapidly extended and will soon include all dry and dusty mines, whether gaseous or not.

Philadelphia and Reading Company Building Two New Breakers

The Philadelphia and Reading Coal and Iron Company has awarded contract for the construction of two modern electrically operated centralized breakers at Locust Summit, Pa. The program also calls for the electrification of mines tributary to the new breakers and the electrification of other facilities. The breakers will have an aggregate capacity of 25,000 tons daily. It was stated that upward of $19,000,000 will be expended on the improvements.

The coal company also awarded a contract to the Westinghouse Electric and Manufacturing Company for three 30,000-ton electric locomotives. These locomotives will be used in the hauling of coal from the company's mines to the new breakers.

Application was made to the New York Stock Exchange to list $30,800,000 of Philadelphia and Reading Coal and Iron Company 6 percent convertible debenture bonds. The proceeds of these bonds are being used for the electrification work and for the retirement of $9,950,000 of notes payable. It is estimated that annual savings of $4,400,000 will accrue to the coal company upon the completion of its electrification program.

The company is planning to produce electricity for its own use and for the distribution of it to communities adjacent to its mines. An application for a charter for distribution rights is now before Governor Fisher, of Pennsylvania.

National Fuels Meeting

The Third National Fuels Meeting will be held in Philadelphia, October 7-10.

The subjects to be discussed include the following: Economics of reclamation of anthracite culm; burning refuse fuels; low-temperature carbonization; the atomic basis of combustion theory; economics of gas, coal and oil fuels; economics of oil production; heat value of fuel; coal pre-treatment; slag accumulations on boiler tubes; air needed for combustion of different fuels; design of furnace for tunnel kilns; development of refractories to meet needs of users; producer gas in brick kilns; fuel burning in ceramic and lime industries; application of fuels in the cement industry; burning pulverized anthracite; recent developments in stoker design; burning coarse coal in suspension; proper methods of pulverized fuel sampling; low-temperature coke for marine service; pulverized fuels in marine practice; methods of recording smoke; the effect of pulverized fuel ash on the penetration of ultra-violet rays and smoke abatement at Salt Lake City.

The ladies too are going in for first aid and mine rescue. The team shown here represents the Nellis, W. Va., mine of the American Rolling Mill Company. Incidentally, these girls won third place in the Nellis meet, which was held Saturday, August 3, competing with six men's teams. They are, left to right—Nina Holmes, Katie Bias, Ruby Barker, Evelyn Shaw, June Holley Keenan, Lella Stewart, Lydia Atkins Easter

Nellis Mine Holds First Aid Meet

On Saturday, August 3, the Nellis, W. Va., mine of the American Rolling Mill Company, held its third annual first-aid day. Saturday morning was devoted to sporting events. Rain at noon called a halt to the outdoors festivities but failed to dampen the ardor of the first-aid contestants. The meet was moved indoors to the Nellis Armco Association club rooms, where the seven well-trained teams demonstrated what they knew in the way of applying first-aid treatments, in spite of the handicap of limited space. The winning team scored 298 points out of a possible 300.

The first ladies team trained at Nellis competed in this meet. Although their scores were not figured in awarding prizes, their work was excellent and compared quite favorably with that of the men. They will enter the Boone County and West Virginia state meets.

C. W. Connor, general superintendent of mines for the American Rolling Mill Company, acted as master of ceremonies, while Ellsworth H. Shriver, superintendent of Nellis mine, served as general chairman. R. G. Adair, Armco's supervisor of safety, directed the meet, with C. M. Allen, safety advisor of their Ashland plant, his assistant. The judges were W. H. Forbes, Walter London, and Tom King, of the New England Fuel and Transportation Co.; Matthew Kerr, Portsmouth By-Product Coke Co.; Archie Forbes, Logan County Coal Corporation; H. E. Ellison, New River Co.; and W. W. Hunter, C. C. & B. Smokeless Coal Co.

Metal Roof Support for Coal Mines

A growing tendency at a number of coal mines to use steel cross bars for the support of the roof along haulage roads has been noted by mining engineers of the Pittsburgh Experiment Station of the Bureau of Mines, engaged in the general study of the subject of mine roof control. These bars are in the form of I beams, H beams, and, in many instances, used railroad T rails, the latter varying from 40 to 90 lbs. per yd. A question has arisen as to the dependability of used railroad T rails for this purpose, especially if the rail has not been annealed before use. Some such T rails have been observed to break under weight with little sagging or bending to indicate that they were under a breaking load. It is assumed that such rails have undergone some form of recrystalization that has added to their brittleness and instead of bending under a load they break with a "snap."

Dr. George P. Merrill, Noted Geologist, Dies

Dr. George P. Merrill, head curator of geology in the National Museum at Washington and one of the foremost geologists of the world, dropped dead in Auburn, Me., August 15 of a heart attack.

Dr. Merrill had been connected with the National Museum 48 years and was a contributor to dictionaries and encyclopedias on geological subjects. He was 75 years of age and was a native of Auburn, Me.

Survey of Commercial Stocks of Coal

Commercial stocks of bituminous coal used largely for industrial purposes amounted to 33,100,000 tons on July 1, 1929, compared with 41,700,000 tons on July 1, 1928, and with 36,900,000 tons on April 1, of this year, according to a survey just completed by the United States Bureau of Mines.

Exports during the second quarter of 1929 average 342,000 tons a week against 226,000 tons in the previous quarter and 270,000 tons during the same period of last year. The weekly rate of home consumption during the second quarter shows the usual seasonal decline following the close of the heating season and amounted to 8,651,000 tons a week as compared with 11,308,000 tons in the first three months of 1929. Compared with the corresponding quarter of last year, however, the current rate of home consumption shows an increase of 4.1 percent, reflecting somewhat improved business conditions which have prevailed in the present year.

In addition to the stocks in the hands of consumers there were 6,629,262 tons of bituminous coal on hand on the docks of Lake Superior and Lake Michigan on July 1, 1929 as compared with 3,648,280 tons at the beginning of the previous quarter.

Stocks of domestic anthracite held by the coal merchants reporting show the usual seasonal increase over the amount in storage on April 1, and are slightly higher than corresponding dates in other recent years.

Coal-Mine Fatalities in July

Accidents at coal mines in the United States during the month of July, caused the death of 148 men, according to information received from state mine inspectors by the Bureau of Mines. Of this number, 31 occurred in the anthracite fields of Pennsylvania; the remaining 117 resulted from accidents at bituminous mines in various States. The total production of coal for the month was 45,628,000 tons, 40,635,000 tons of which was bituminous and 4,993,000 tons was anthracite. Based on these figures, the death rate per million tons of coal produced was 3.24 for the industry as a whole, 2.88 for bituminous coal, and 6.21 for anthracite coal. The death rates for July, a year ago, were 2.92 for bituminous, 5.36 for anthracite, and 3.19 for both bituminous and anthracite combined. The rates for July showed a decrease from those of the preceding month of June for bituminous and also for anthracite mines.

Records compiled by the Bureau of Mines covering the first seven months of 1929 show a reduction in the coal industry's death rate, not only for the industry as a whole, but also for anthracite and bituminous mines considered separately. During the first seven months of 1929, 1,142 men lost their lives in coal mines. The production of coal for this period was 335,704,000 tons, resulting in a death rate of 3.40. The bituminous death rate during these months was 3.04, based on 894 deaths and 293,842,000 tons of coal mined; that for anthracite was 5.92, based on 248 fatalities and 41,862,000 tons. For the same period in 1928, the fatality rate for bituminous mines alone was 3.86, with a production of 270,565,000 tons of coal and 1,044 deaths. The rate for anthracite was 6.21, based on 41,578,000 tons and 258 deaths, while for the total industry a death rate of 4.17 was shown, with a production of 312,143,000 tons and 1,302 fatalities.

The month of July was free from major disasters—that is, accidents in which five or more men lost their lives. However, there have been four such disasters thus far in 1929. Three of these were explosions which killed 70 men and one was a fall of slate, killing 5 men. Based exclusively on these major disasters, the death rate per million tons of coal produced during the period from January to the end of July was 0.22 as compared with 0.93 for the same months in 1928, based on 290 deaths, which resulted from 9 accidents.

A comparison of the accident record for the first seven months of 1929 with that for the same period of 1928, showed a reduction in the death rate for falls of roof and coal, gas or dust explosions, explosives, and electricity, while an increase is noted for haulage.

Record Shipment of Lake Erie Coal

Movement of bituminous coal to Lake Erie ports for shipment by boat to Upper Lake Erie points has been the heaviest so far this year of any corresponding period in recent years, according to the car service division of the American Railway Association.

From January 1, to August 11, this year, inclusive, 21,128,196 tons of bituminous coal were dumped into vessels at Lake Erie ports. This was an increase of 3,737,104 tons over the corresponding period of last year and an increase of 303,005 tons over the corresponding period in 1927. It also exceeded the corresponding periods in 1924, 1925 and 1926.

On August 12 there were 22,606 cars of bituminous coal on hand at Lake Erie ports ready for dumping, compared with 21,682 on the same date last year and 17,082 on the same date in 1927.

Ask U. S. to Study Saving of Fuels

Movement has been started by the American Bureau of Shipping to have the Federal Government take over the fuel-conservation work now being done by the Shipping Board, to guarantee its future maintenance.

Captain Charles A. McAllister, president of the bureau, believes American merchant shipping will lose its valuable asset, if the fuel-conservation studies are allowed to lag with the progressive withdrawal of the Shipping Board from the marine field. He says that the work of the fuel-conservation unit will not require an expenditure of more than $60,000 a year, and its value, he said, is infinitely greater than that.

Railroads Favor Low Rate on Export Coal

Three important tidewater railroads are now in favor of a special, low rate on coal for export, according to a statement by the Coal Exporters Association. The statement says that these three roads, the names of which are not given, have become convinced that special rates are necessary to supplement the efforts of the United States Shipping Board. The hope was expressed that other tidewater lines soon would join the movement to obtain lower rates on export coal.

The Shipping Board now has nine vessels in the export coal trade. In the first six months of 1929 these vessels exported over 150,000 tons of coal, chiefly to Italy. A few cargoes have gone to Egypt, Algeria, and South America. As a result there has been a marked increase in the use of American coal in the Mediterranean. Generally speaking, the export of coal has been decreasing throughout the world, so that this increase is considered remarkable.

The increase was not procured by any cut in the ocean rate. The Shipping Board merely stabilized the rate and provided continuity of service. The exports are therefore still confined to "specialty" coals, and a decrease in transportation charges is necessary before our coals can compete in the general foreign coal market and this decrease can only be afforded by the railroads, according to the Exporters Association.

Marketing Code Booklet Ready For Distribution

32-page booklet, representing a pocket-size edition of the "National Code of Practices for Marketing Refined Petroleum Products" and containing authorized interpretation of the code, has been issued by the American Petroleum Institute.

The handy booklet is available to the petroleum industry generally. It will be supplied in small quantities without charge to members of regional, state or sub-committees desiring to distribute it for educational purposes. Companies desiring to obtain copies in quantity for distribution to dealers, salesmen and others will be supplied at a quoted low rate.

Accidents From Falls of Mine Roof

A review of published reports of the mine-inspection services of 19 states has been made by the Bureau of Mines to ascertain the character of the data relating to accidents from falls of mine roof and sides, to determine how the data will be helpful in a study of the problem, and to suggest methods for the prevention of such accidents. These 19 states produced 95 percent of all of the coal mined in the United States during 1927, and falls of roof or sides in the mines of these states killed 1,067 men, a number equal to 54 percent of all underground fatalities. A summarization of this review has been published as Information Circular 6110, a copy of which may be obtained from the bureau.

Economics of Gypsum Industry

R. M. Santmyers, mineral specialist, United States Bureau of Mines, has completed a field trip in the course of which he visited gypsum deposits and plants in the New England States and the Maritime Provinces of Canada, for the purpose of obtaining information relative to the producing and distributing facilities of the gypsum industry. The information gathered is to be used in an economic study of the gypsum industry of the United States, Canada, and Mexico.

An interesting feature of the industry in Nova Scotia is the loading of the ships. The rise and fall of the tide, especially in the vicinity of the Minas Basin, reaches more than 40 feet, necessitating the use of flat bottomed vessels and specially built cribbing, as the ships are frequently high and dry at low tide.

Treatment of Chrome Ores

A study of chemical methods of treating chrome ore has been taken by the Rare and Precious Metals Experiment Station of the United States Bureau of Mines, Department of Commerce, in cooperation with the University of Nevada, Reno, Nev. This study is a phase of a general investigation of methods by which domestic deposits of chromium ores may be utilized in competition with foreign supplies if possible, but primarily as an emergency reserve in case of shortage and high prices resulting from war or foreign monopoly.

The increasing market for chromium-plated articles and low carbon-high chrome-steels has stimulated the demand for chromates, chromic acid and chromic oxide of high purity.

By methods utilizing cheaper reagents and less costly operations, chemically pure chromic oxide has been obtained from typical lower-grade domestic ores. These methods have been tested only on a laboratory scale, but they appear to be suitable for commercial application.

George S. Rice is Awarded British Mining Medal

George S. Rice, chief mining engineer of the Bureau of Mines, Washington, has been chosen as recipient of the medal of the Institution of Mining Engineers, of Great Britain, in recognition of his eminence in all matters relating to the safe working of coal mines.

SOUTHERN MINERAL RESOURCES
(*from page 670*)

grown rapidly in the South during the past few years. The construction of good roads has taken a large percent of that produced. In 1928 the South consumed about 23 percent of the total production in the United States.

"One state, North Carolina, produces one-half of the feldspar (a material used in the white ware industry) and mica consumed in America. The reserves of these minerals in Georgia, North and South Carolina and Virginia are unlimited.

"In reviewing these natural resources we find that the South offers a greater variety of resources and more abundantly than any other section of the world. These sixteen Southern States could be set apart from the rest of the world and the people could live in ease and luxury indefinitely. Yet with this abundance of natural resources the South has to depend on other sections for many of the necessities of life. As an example, the South has a larger supply and produces more of the crude materials used in the manufacture of china ware and electrical porcelain than any other section, yet only a limited amount of these products are produced in the South. The South produces the crude materials, they are shipped north where they are manufactured, then the finished product is reshipped South. The Secretary of State of Georgia has said that 10 cents worth of Georgia clay shipped to Ohio, made and moulded by the head and hand of a man who knew, brought $25. Georgia received 10 cents and Ohio $24.90. This same thing was once true of the textile industry. The South produced the cotton, New England manufactured it, the South received 10 cents and New England 90 cents. Due to the foresightedness of a few men, the South has come into its own in the manufacture of textile products. Today it is estimated that only 15 percent or 20 percent of the capital invested in southern textile plants was furnished by people outside the South. The southern textile industry is a home owned industry. Has not the growth of this industry attracted the attention of the entire world? If such success can be had in this industry, can it not be had in others where the South has and produces the crude materials?"

Dr. Bryson stated that the South is undergoing an economic revolution which is changing it from an agricultural to an industrial section. Statement was made by Dr. Bryson that the 16 Southern States produced 33 percent of the mineral products of the country, 11 percent of the blast furnace products, and that they have 13 percent of the potential water power resources and 24 percent of the developed water power. "The continued growth and prosperity of the South will depend very largely on what use the people make of their natural resources," said Dr. Bryson. "There is no other section of the country endowed with a greater abundance of resources. If used wisely some of these resources are safe and permanent foundations upon which to build a great South." He suggested that an inventory be taken of the natural wealth in the South and a digest made of the industries which are based for most part on this natural wealth.

Dr. Bryson also reviewed the forest and water power resources of the South.

Dr. Henry Mace Payne, consulting engineer to the American Mining Congress, said there is "a general need throughout the South for cooperation and co-ordination in the conservation and intelligent utilization of natural resources." He said: "The undeveloped natural resources of the South are the industrial currency of the coming generation." Dr. Payne stated, "the area from Norfolk to Kansas City and south to San Antonio, embracing the southeast quarter of the United States, is so endowed with natural resources as to be capable of complete self-support.

"We find an abundance of fuels, both liquid and solid; of building materials, both of stone and wood; of limestones and the constituent elements of cement; we find cotton and wool, agricultural products and fruits of the widest diversity for human consumption; shell-fish and marine edibles of all kinds, wild game in abundance; transportation facilities and means of communication wholly adequate; deep sea ports for the vessels of commerce, inland waterways coordinating with great transportation systems; great manufacturing and refining centers of steel and copper, zinc and lead; the greatest deposits of high-grade non-metallics existent in the world; vast areas of pasturage for cattle and sheep; stock farms for the breeding of blooded stock; climatic conditions from sea level to mountain peak, wet and dry, hot and cold, to suit the extreme tastes of the individual; a health rate unexcelled, and in fact everything necessary to human enjoyment and industrial prosperity."

He stressed the importance of utilizing natural resources near their point of production, and the intelligent development and adaptation of hydro-electric power and adaptation of hydro-electric power and its transmission over wide areas.

WITH THE MANUFACTURERS

Roberts and Schaefer to Build Large Coal Plants in Russia

The Robert Schaefer Company, engineers and contractors, of Chicago, announce the closing of a contract of more than $3,000,000 with the State Coal Trust (in Russia called "Donugol") of the U. S. S. R. This contract has been approved by the Supreme Council for Peoples Economics, and also by the Concessions Committee of the Council of Peoples Commissiaries, a formality required in the U. S. S. R. for all international contracts.

This contract calls for the designing and supervision of the building of coal mining, coal preparation, storage, loading, etc., for four large, new coal mines. These plants are to be designed and built according to the most approved American practice.

Col. Warren R. Roberts and President G. I. Lomov, of the Donugol, signing contracts for Russia's new coal plants in Mr. Lomov's office in Kharkov, Ukraine. Seated, from left to right, are Colonel Roberts, Mr. Lomov, and R. G. Lawry, of Roberts and Schaefer. Behind them are E. T. Abakumov, general manager, S. S. Dookelsky, member of board of directors, and Nicholas I. Levtchenko, vice president of Donugol

Colonel Warren R. Roberts, chairman of the board of Roberts and Schaefer Company, who had charge of the negotiations, returned to the United States the first of August. He said that his firm had been invited to visit the Don Basin after the Soviet commission which had been studying American industrial conditions had found their method of pneumatic coal cleaning better adapted to their condition than methods already in use in the Don Basin.

The contract includes the complete operating plants above ground for four large, new coal mines—one anthracite and three bituminous. All engineering work for the building of these plants is to be completed in thirteen months. The designing for the tipples, the sizing plants, the coal cleaning plants (by the air process), hoisting plants and all other units will be done in Chicago by the company's engineers with the cooperation of engineers of the Donugol, and will be made according to the best American practice. Construction work on each project will start soon after the plans and specifications for that project are completed, the plants to be built by Donugol under Roberts and Schaefer supervision.

While it has not been fully decided as to just what machinery is to be supplied from America, a Russian Commission of Engineers is already in this country to visit operating plants and factories where such machinery is to be built, and it is expected that for the most part the coal hoisting and preparation equipment will come from America in order to suit the requirements of the designs.

The Engineering Commission mentioned above consists of N. I. Levtchenko, vice president of Donugol, A. V. Wolkenau, chief mining engineer, and Nicholas Gratschen, chief mechanical engineer. In addition to these men, there will also be sent in the near future, eight young engineers who are to work on plans and specifications and help translate all the information on the plans and specifications, etc., into Russian.

The new construction planned will increase the annual output of the Don mines, now 26,000,000 tons, by 3,500,000. The Donugol plans to increase the annual production to 75,000,000 tons in five years, and when Roberts and Schaefer's present projects are completed they will receive orders for the erection of further plants.

Colonel Roberts attributes the economic improvement in Russia to the policy of the government. "Formerly," he said, "the money went into the erection of palaces and churches. Now every dollar that can be scraped up is devoted to economic development. The Russian worker, however, is not as efficient as the American worker, but under the new and better social conditions the standard of efficiency is improving every year."

Colonel Roberts was accompained on his visit to Russia by R. G. Lawry, mining engineer on the staff of the company, and by his daughter Miss Elizabeth E. Roberts, attorney, who helped draw up the contract.

Centrifugal Compressor Catalog

A new catalog on centrifugal compressors and blowers just issued by the De Laval Steam Turbine Co., Trenton, N. J., illustrates the remarkable progress being made by centrifugal machinery in many fields. Turbine-driven blast furnace blowers rated at 60,000 cu. ft. per minute against 30 lbs. maximum pressure at 2,800 r.p.m. are shown. Both single and multistage blowers and boosters are shown for use in water gas plants, and in connection with coal gas retorts and coke ovens. Higher gas pressures are becoming general in the gas industry for the transmission of large quantities of gas through existing mains or to reduce the first cost of mains for long distance distribution. For this work large multistage compressors are used, driven by steam turbines or variable speed motors, the latter being connected to the compressor in some instances by speed increasers. Centrifugal blowers and compressors are also applied to blowing Bessemer converters, supplying air to oil and gas fired furnaces, blowing cupolas, agitation of liquids, as in the activated sludge method of sewage purification and in flotation methods of ore separation, also for the pneumatic handling of materials, super-charging Diesel engines, etc. The De Laval book closes with a concise presentation of the mechanics and thermodynamics of the compression of gases and the physical properties of industrial gases, with numerous illustrative examples worked out in detail.

Contract Awarded for Large Tipple and Cleaning Plant

The American Coal Cleaning Corporation, of Welch, W. Va., and the Link-Belt Company, of Philadelphia, Pa., have been awarded the contract for a tipple and coal cleaning plant, which will be one of the largest of its kind in the Pocahontas field, by Harry Faust, general manager of the United Pocahontas Coal Company, at Crumpler, W. Va.

The plant will serve the three large mines of the company—Wyoming, Zenith, and Indian Ridge—and will be located at Crumpler, which is a central point.

Twin rotary dumps will handle the coal which will be brought from both sides of the hollow and handled at the rate of 4,000 tons per day. The structure will be all steel construction and will contain screens and equipment for preparing all sizes of coal for the market. The lump will be hand picked, while the smaller sizes will be cleaned mechanically by the latest and most up-to-date improved types of coal cleaning machinery.

The American Coal Cleaning Corporation will furnish the pneumatic cleaning machinery for treating the slack coal, together with a complete dust collecting system of the latest type, which will prevent any dust from causing a nuisance in the town in which it is located.

The contract for the complete plant has been awarded to the Link-Belt Company, of Philadelphia, who will furnish all the equipment except that mentioned above, and will include the Simon-Carves washer for cleaning the coal between the lump and slack sizes. This washer has recently been introduced into this country by the Link-Belt Company, but has been extensively used in England for some time.

Work will begin immediately on the construction of this plant, and it will be completed by the early spring.

This is probably the largest contract for such equipment to be signed in this field for some years.

New Drum Switch Operating Mechanism Makes Better Line-up in Crane Cabs

The General Electric Company announces a new type of operating mechanism for use with drum switches mounted in crane cabs and similar places. This mechanism, superseding the rack-and-pinion under-lever type, eliminates the trouble experienced in keeping a perfect line up between the shaft of the operating mechanism and the drum switch shaft, and makes it possible to enclose the mechanism to keep dirt from the gear lubricant.

The mechanism consists of a pinion on an extended drum switch shaft, meshing with a segment gear, all housed in a dust-tight cast case provided with plugged access hole for gear slushing and with a short lever arm projecting below the case. The lever arm can be connected with the reach rod in the same way as with the old rack-and-pinion type.

The new mechanism will be assembled with the drum switch by the manufacturer.

Koppers-Rheolaveur Plant for Buckeye Coal Company

Koppers-Rheolaveur Co. recently closed a contract with the Buckeye Coal Co., a subsidiary of the Youngstown Sheet & Tube Co., for a 600-ton-per-hour coal-washing plant. This plant will wash all of the coal from the Nemacolin mine of the Buckeye Coal Co., which will amount to from 6,000 to 8,000 tons per day.

The coal will all be used for metallurgical purposes; that is, for the making of coke for metallurgical purposes. In order to get the maximum reduction in ash and sulphur and to supply a small amount of fuel for steam purposes, the plant will operate on the basis of a three-product separation or a low ash, low sulphur metallurgical coal; a higher ash, higher sulphur coal for steam purposes; and refuse.

The coal hoisted is now delivered to a very large and very efficient mixing bin which has just been completed. From this bin the coal will be fed into the new washing plant at the rate of 600 tons per hour. The 4 x 5/16 in. coal will be washed in a double 48-in. two-box Rheolaveur washing plant and the refuse cleaned in rewash launders. After receiving a preliminary washing in the main launders, the minus 5/16-in. coal will be washed finally in a four-launder free-discharge Rheolaveur plant.

Care has been taken to obtain very large screen area on the plus 5/16-in. coal so that the maximum amount of draining and drying can be accomplished on these sizes. The minus 5/16-in. coal will be dried in six Carpenter driers. The sludge or minus 100-mesh material from the plant will be settled by a very

Sanford-Day's New Automatic Dumping Mine Car

A new, practical, big capacity automatic dumping mine car is being offered the mining industry by the Sanford-Day Iron Works, Inc., of Knoxville, Tenn.

The "Double-Automatic" has the same patented principle of automatically opening and closing of the bottom doors as the S&D Griffith Standard "Automatic," with the additional feature of the side sections, which extend out over the wheels, being so hinged to the frame channel, that they raise and discharge their part of the load through the bottom also.

This construction gives the maximum capacity obtainable in any type of car for the same overall dimensions. In fact, it gives more capacity than other type cars because the drop-bottom doors curve down below the axles, which adds materially to the capacity, and the lading bottom of the side section is below the top of the wheels, which gives extra capacity also. Where the wheels cut bottom, which extends out beyond through that section of the lading the width of the track, hoods or shrouds are provided to close these openings.

The operation is simple. As the trip of cars moves across the storage bin, a tripping device placed alongside of the track comes in contact with a latch lever on each car, causing the bottom doors of each car to dump first, discharging the central load, and immediately thereafter, as the trip proceeds, a device raises the sides of each car and dumps them. This same device lowers the sides immediately to their normal position and the bottom doors close by passing over a knuckle in the center of the track at the other end of the bin as the trip passes over. One continuous operation—no stopping—no coupling—no labor. The motorman and trip-rider handle the entire operation, dumping 20 to 30 cars a minute.

large thickener and dewatered by Zimmer screens and filters. After being dewatered down to where the sludge will contain approximately 20 percent moisture, this sludge will be further dried in a rotary head drier to prevent freezing when loaded into the cars. In this way, drier coal is obtained and heat used only on a very small portion of the total tonnage, approximately 2 or 3 percent.

Many unique features and innovations will be built into this plant. The amount of money to be expended by the Youngstown Sheet & Tube Co. on this development will be in the neighborhood of a million dollars, but this has only been done after extensive tests have been made as to the value of clean coal for metallurgical coking purposes, and it has been determined that the savings more than warrant the expenditure which will be made.

Forced Draft Fans

The use of low grade, cheap fuels has been made possible in the last few years by the adoption of small forced draft fans and special grates on domestic and other small furnaces and boilers. The American Blower Corporation has published a catalog showing standard forced draft fans suitable for this use. The catalog also gives application and technical data of interest to any who contemplate installations of this kind. It is claimed that the use of the cheaper grades of fuel will pay for the necessary equipment in a very short time without loss of heating efficiency in the furnace. It is also claimed that the use of the forced draft blower gives quicker "heating up" capacity and more flexible operation. The American Blower Corporation, Detroit, Mich., will be glad to send a copy of their bulletin No. 10401 on this subject upon request.

World's Largest Transformers

Strengthening of bridges and the lowering of railroad tracks 18 inches at one point to permit clearance, will be necessary to transport the four largest electric power transformers ever built from the Westinghouse Electric and Manufacturing plant at Sharon, Pa., to Roseland, N. Y., near Newark.

They will be used to transfer power at the Pennsylvania Power and Light Company's plant at Bushkill, Pa., to the Public Service Electric and Gas Company's system in New Jersey. Fifty-six freight cars will be necessary to carry the transformers and parts over the Erie Railroad.

Each transformer is 35 feet high, weighs approximately 300 tons, and requires a floor space 22 by 23 ft. More than three tank cars of oil, or 32,000 gals., will be required to fill each transformer.

The transformers are rated at 220,000 v., but were tested at 570,000 v., the highest test voltage ever applied to a power transformer. The core and coils in each transformer contain 63 tons of laminations and 15 tons of copper windings. There are more than 32 miles of wire in the copper windings in each transformer.

The weight of each transformer, as prepared for shipment, is 270,000 pounds, one of the heaviest individual units ever shipped on single railroad cars. It was necessary to utilize a special depressed type of equipment to permit clearance under vehicular and cross line bridges along the right of way. To further meet the requirements, the tracks at Caldwell, N. J., will be temporarily lowered 18 inches to permit clearance.

In addition to the four special depressed cars 18 well type cars, 14 gondolas, 6 ordinary flats and 14 oil tank cars will be necessary to handle the consignment.

Each transformer was packed in a specially designed shipping tank. In order to meet the loading requirements of the Erie Railroad, the oil was drained from the transformers and the shipping tanks were filled with dry nitrogen gas to preserve the insulating qualities of the coils in transit.

Armored Cables of Large Diameters Now Available

Power and control cable with interlocked, flexible metal armor for installation without a conduit in central station, industrial and other interior wiring has been announced by the General Electric Company. Cable provided with the armor can be run along walls, between partitions and under floors without the use of ducts, and the construction of the armor is such that turns in the cable can be made easily.

Varnished cambric and rubber-insulated, either taped, braided or leaded, and paper-leaded cable can be supplied with the armor, in lengths up to 1,000 ft. for cables with an overall diameter less than one inch and in lengths up to 2,000 ft. for cables with an overall diameter between 1 and 3 inches. The cables can have any number and combination of conductors, and any outside diameter up to 3 inches.

The armor is a layer of overlapping and interlocking metal tape, either galvanized steel or aluminum, so applied that the cable is always mechanically protected under reasonable installation conditions. The steel armor is suitable for most installations; the aluminum tape is for use where a non-corroding armor is required, and for single conductor cable carrying alternating current where the magnetic effect of steel is undesirable.

Jeffrey Mfg. Company Announces Appointment of New Officers

The Jeffrey Manufacturing Company, Columbus, Ohio, announces that Mr. C. W. Miller has resigned as treasurer of the company, but will continue as a member of the board of directors.

Mr. H. Supp, Jr., formerly credit manager, has been elected treasurer to succeed Mr. Miller. Mr. J. X. Farrar, formerly assistant purchasing agent, has been appointed credit manager, succeeding Mr. Supp.

New Westinghouse Publications

The Westinghouse Electric and Manufacturing Company announces the publication and distribution of its leaflet No. 20392, entitled, "Cog Belt Drives for Industrial Service." The uses, advantages, and construction of cog belt drives are clearly and concisely explained. Illustrations of construction and application of these drives are included. The leaflet also includes a table of available standard sizes of belts.

"Westinghouse Geared Turbine-Generator Units" is the subject of another recent release. The pamphlet, No. 20378, includes material on the general features and construction of the new 25 to 50 kw. d-c. geared turbine-generator sets. Photos and drawings show assembly, parts, and special devices of the new units. The available ratings with dimensions are also included.

Leaflet No. 20418 describes the 300 ampere, gas engine driven, arc welding set. It explains the construction of the stationary and portable units which are used where local power supply is not available as in the case of pipe line and storage tank construction. The motor and generator control is described in a simple manner. Illustrations and specifications are used to show and explain the special accessories and features.

Leaflet 20340-B covers the new 300 and 400 ampere single operator welding sets, portable and stationary. This leaflet contains information on these two welders concerning the general assembly, ratings, details and dimensions with a large photograph of each shown.

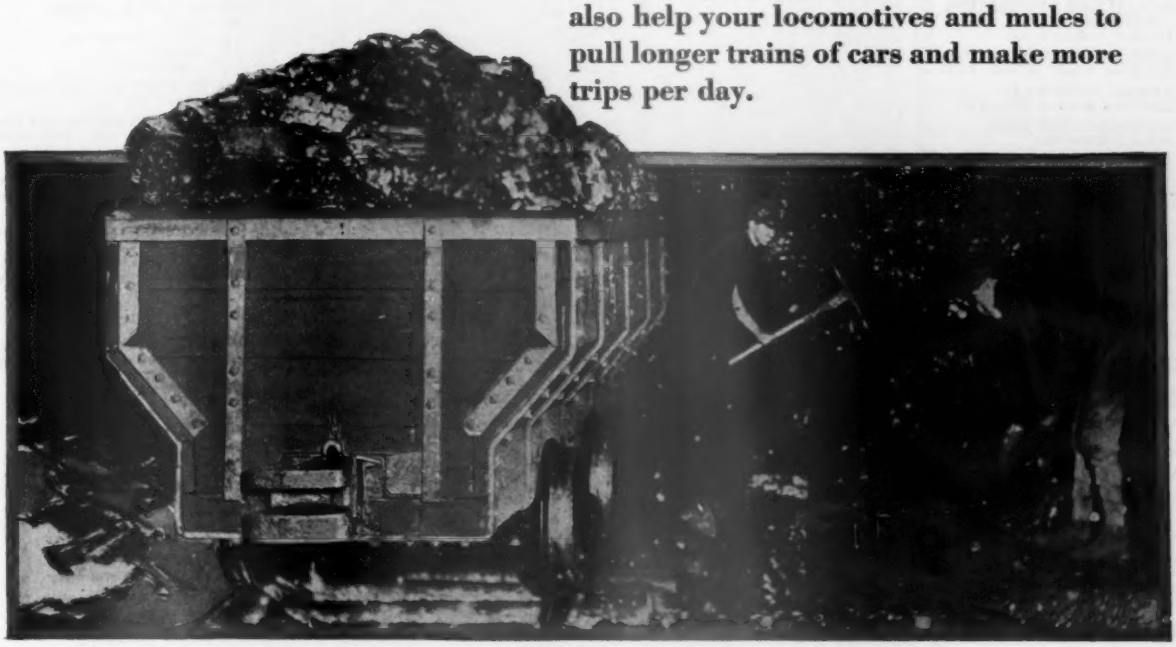
Sales of the Gardner-Denver Co. for the first two weeks in August have exceeded those of last year by a fair margin, according to an announcement by Ralph G. Gardner, vice president. Production of the Quincy, Ill., and Denver, Colo., plants is being increased to take care of the large volume of unfilled orders. Part of this additional output is being effected through the employment of a night force in the Quincy plant.

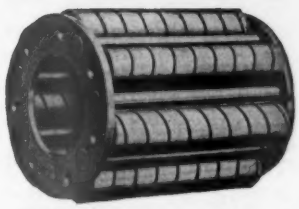
The Gardner-Denver Co. manufactures slush pumps, air compressors, high-pressure drill steel forges, rock drills, and drill steel sharpeners. It also has a plant at La Grange, Mo.

Eliminate Haulage Troubles *the* HYATTWAY

MINE cars that serve you well, year after year...without need for bearing adjustment, replacement, or inspection . . . reduce haulage costs, and increase mining profits.

Hyatt Roller Bearings under all your cars give you this kind of service. They also help your locomotives and mules to pull longer trains of cars and make more trips per day.





The Hyatt Roller Bearing used in mine cars is pictured above. The rollers are hollow cylinders formed by helically winding strips of alloy steel.

The only attention Hyatts ever require is only an occasional one-man job...even at the largest mines . . . namely, a shot of grease per wheel a few times a year. That is all that is necessary to assure their dependable performance.

For two decades, mine supers have habitually specified Hyatt Roller Bearings as standard equipment for their cars. They know that the Hyattway is the best way to permanently eliminate their haulage troubles.

HYATT ROLLER BEARING COMPANY

Newark Detroit Chicago Pittsburgh Oakland

HYATT

ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

BUYER'S DIRECTORY

ACETYLENE, Dissolved (Or in Cylinders)
Prest-O-Lite Co., Inc.

ACETYLENE GAS
Prest-O-Lite Co., Inc.

ACETYLENE GENERATING APPARATUS
Oxweld Acetylene Co.

ACID, SULPHURIC
Irvington Smelt. & Ref. Works.

AERIAL TRAMWAYS
American Steel & Wire Co.

AFTERCOOLERS (Air)
Ingersoll-Rand Co.

AIR COMPRESSORS
Allis-Chalmers Mfg. Co.
Sullivan Machinery Co.
Ingersoll-Rand Co.

AIR COMPRESSOR OILS
Standard Oil Co. (Ind.)

AIR FILTERS—Bag type
American Coal Cleaning Corpn.

AIR HEATERS
Westinghouse Electric & Mfg. Co.

AIR LIFT PUMPING
Sullivan Machinery Co.

ALL SERVICE GAS MASKS
Mine Safety Appliances Co.

ANEMOMETERS
Mine Safety Appliances Co.

ANNUNCIATOR WIRES & CABLES
Roebling's Sons Co., J. A.

ANNUNCIATOR WIRES & CABLES, INSULATED
American Steel & Wire Co.

ANTI-RUST OILS & GREASES
Standard Oil Co. (Ind.)

ARMATURE COILS & LEADS
General Electric Co.
Roebling's Sons Co., J. A.
Westinghouse Electric & Mfg. Co.

ARMORGRIDS
General Electric Co.

ASPIRATORS
American Coal Cleaning Corpn.

AUTOMATIC CAR & CAGER STOPS
Link-Belt Co.
Mining Safety Device Co.

AUTOMATIC CAR CAGES
Connellsville Mfg. & Mine Supply Co.
Link-Belt Co.
Roberts & Schaefer Co.

AUTOMATIC CAR DUMPERS
Link-Belt Co.
Roberts & Schaefer Co.

AUTOMATIC FLAGGING SIGNALS
American Mine Door Co.

AUTOMATIC (Mine Doors, Trucks and Electric Switches)
American Mine Door Co.

AUTOMATIC MINE SWITCHES
Westinghouse Electric & Mfg. Co.

AUTOMATIC SWITCH THROWERS
American Mine Door Co.
Westinghouse Electric & Mfg. Co.

AUTOMOBILE CABLES
Roebling's Sons Co., J. A.

AUTOMOTIVE LUBRICANTS
Keystone Lubricating Co.

BAG TYPE AIR FILTERS
American Coal Cleaning Corpn.

BALLAST UNLOADER ROPES
Roebling's Sons Co., J. A.

BARS, STEEL
Carnegie Steel Co.
Timken Roller Bearing Co.

BATTERIES
E. I. du Pont de Nemours & Co.

BATTERIES, Armature
Westinghouse Electric & Mfg. Co.

BATTERIES, Blasting
Hercules Powder Co.

BATTERIES, DRY (for Bells, Buzzers, Signals, Blasting)
National Carbon Co., Inc.

BATTERIES (Storage, Gas Welding, Cutting, Dissolved Acetylene)
Prest-O-Lite Co.
Westinghouse Electric & Mfg. Co.

BATTERY CHANGING STATION
Atlas Car & Mfg. Co.

BEARINGS (for all kinds of equipment)
Hyatt Roller Bearing Co.

BEARINGS, RADIAL
Timken Roller Bearing Co.

BEARINGS, TAPERED ROLLER
Timken Roller Bearing Co.

BEARINGS, THRUST
Timken Roller Bearing Co.

BELL CORD
Roebling's Sons Co., J. A.

BELT DRESSING
Standard Oil Co. (Ind.)

BELTING (Conveyor, Elevator, Transmission)
The Jeffrey Mfg. Co.
Link-Belt Co.

BELTING, SILENT CHAIN
Link-Belt Co.
Morse Chain Co.

BINS (Coke and Coal)
The Jeffrey Mfg. Co.
Link-Belt Co.

BIT BOXES
Mine Safety Appliances Co.

BITS, Carbon (Diamonds) for Core Drill
R. S. Patrick.
Diamond Drill Carbon Co.

BITS, Diamond Drilling
R. S. Patrick.

BIT SHARPENERS
Sullivan Machinery Co.
Ingersoll-Rand Co.

BLACK DIAMONDS
Diamond Drill Carbon Co.
R. S. Patrick.

BLACK OILS
Standard Oil Co. (Ind.)

BLASTING ACCESSORIES
E. I. du Pont de Nemours & Co.

BLASTING CAPS
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

BLASTING MACHINES
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

BLASTING POWDER
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

BLASTING SUPPLIES
Hercules Powder Co.

BLASTING UNITS (Dry Battery)
National Carbon Co., Inc.

BLOWERS, CENTRIFUGAL
American Coal Cleaning Corpn.
General Electric Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.

BLOWERS (or Compressors)
General Electric Co.

BLOWERS (Tubing)
The Jeffrey Mfg. Co.
Robinson Ventilating Co.

BLOWERS (Turbine)
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.

BLOWPIPES, Brazing, Carbon Burning, Cutting, Lead Burning Welding, Welding and Cutting
Oxweld Acetylene Co.

BLUE CENTER STEEL WIRE ROPE
Roebling's Sons Co., J. A.

BOND TERMINALS
American Mine Door Co.

BORTZ
R. S. Patrick.
Diamond Drill Carbon Co.

BRACES, GAUGE
Central Frog & Switch Co.

BRACES, RAIL
Central Frog & Switch Co.

BRACES, TRACK
Central Frog & Switch Co.

BRAZILIAN ROCK CRYSTAL
Diamond Drill Carbon Co.

BREAKER MACHINERY
Koppers-Rheolaveur Co.
Vulcan Iron Works.

BREAKERS
American Coal Cleaning Corpn.

BREAKERS (Construction and Machinery)
The Jeffrey Mfg. Co.

BREAST MACHINES
Goodman Mfg. Co.

BRIQUETTING MACHINERY
Vulcan Iron Works.

BRUSHES (Carbon, Graphite and Metal Graphite for Electric Motors, Generators and Converters)
National Carbon Co., Inc.
Westinghouse Electric & Mfg. Co.

BUCKETS (Elevator)
Atlas Car & Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

BURRELL, GAS INDICATORS, GAS MASKS, MINE AIR ANALYZER
Mine Safety Appliances Co.

CABLE COMPOUNDS
Standard Oil Co. (Ind.)

CABLE—DRILLING, WIRE
American Cable Co.

CABLE—ELEVATOR, MACHINE, ETC. (STEEL)
American Cable Co.

CABLE GREASE
Keystone Lubricating Co.

CABLE—HOISTING
American Cable Co.

CABLE — MINING (HAULAGE, SHAFT HOIST, MINING MACHINE, SLUSHER)
American Cable Co.

CABLES
American Steel & Wire Co.
Roebling's Sons Co., J. A.

CABLES (Connectors and Guides)
American Mine Door Co.

CABLES, INSULATED
General Electric Co.
Roebling's Sons Co., J. A.

CABLES, SUSPENSION BRIDGE
American Cable Co.
Roebling's Sons Co., J. A.

CABLEWAYS
American Steel & Wire Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

CABLE—WIRE
American Cable Co.

CAGE DUMPERS, ROTARY
Link-Belt Co.
Roberts & Schaefer Co.

CAGES (Safety Appliances)
Connellsville Mfg. & Mine Supply Co.

CAGE STOPS & LOCKS
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CAGERS, AUTOMATIC
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAGERS, AUTOMATIC & MANUAL
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CAGES
Allis-Chalmers Mfg. Co.
C. S. Card Iron Works Co.
Connellsville Mfg. & Mine Sup. Co.
Link-Belt Co.
Vulcan Iron Works.

CAGES (Self-dumping)
Link-Belt Co.
Roberts & Schaefer Co.
Vulcan Iron Works.

CALCINERS
Vulcan Iron Works.

CALCIUM CARBIDE
Union Carbide Sales Co.

CARBON AND BORTZ
Diamond Drill Carbon Co.
R. S. Patrick.

CARBON FOR DIAMOND DRILLING
Diamond Drill Carbon Co.
R. S. Patrick.
Sullivan Machinery Co.

CARBON BURNING APPARATUS
Oxweld Acetylene Co.

CARBON ELECTRODES (for Electric Furnaces and Electrolytic Work)
National Carbon Co., Inc.
Westinghouse Electric & Mfg. Co.

CARBON MONOXIDE DETECTOR
Mine Safety Appliances Co.

CARBONS (for Arc Lamps, Blue Printing, Photographic)
National Carbon Co., Inc.

CARBON RODS AND PASTE FOR WELDING
Oxweld Acetylene Co.
National Carbon Co., Inc.

CARBON SPECIALTIES (Circuit Breaker Contacts, Packing Rings, Filter Plates, Tubes, etc.)
National Carbon Co., Inc.

CAR DUMPERS, GRAVITY & POWER
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAR DUMPERS (Rotary)
Connellsville Mfg. & Mine Supply Co.
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAR FEEDERS
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CAR HAULS
Goodman Mfg. Co.
Hockensmith Wheel & Mine Car Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

CAR PULLERS
Allis-Chalmers Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

CAR REPLACERS
Johnson Wrecking Frog Co.

CAR RERAILERS
Johnson Wrecking Frog Co.

CAR RETARDERS
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

CARS OF ALL DESCRIPTION
Hockensmith Wheel & Mine Car Co.

CAR STOPS, AUTOMATIC & MANUAL
Link-Belt Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

CAR WHEEL LUBRICANTS
Keystone Lubricating Co.

CAR WIRE & CABLES
American Steel & Wire Co.
John A. Roebling's Sons Co.

CASTINGS
Goodman Mfg. Co.
Link-Belt Co.
The Jeffrey Mfg. Co.
Timken Roller Bearing Co.

CASTINGS, GRAY IRON
Link-Belt Co.
Vulcan Iron Works.

CASTINGS, OPEN HEARTH, STEEL
Vulcan Iron Works.

CASTINGS (Steel, Iron)
Vulcan Iron Works.

CAST STEEL FROGS
Central Frog & Switch Co.

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PROGRESSIVE engineers recognize Oxwelded piping as the best modern practice. Oxwelded joints are leakproof. Maintenance costs are practically nil. The Oxwelded joint will last as long as the pipe itself. Costly special fittings are eliminated: fittings can be fabricated with cutting and welding blowpipes right on the job. Lighter pipe may often be used. Pipe may be purchased in longer lengths. Additions and changes may be made at lower cost.

"A properly made oxy-acetylene welded joint is as strong as the base metal, fully 100% efficient . . . ."

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The Linde Air Products Company

UNION CARBIDE
Union Carbide Sales Company

Prest-O-Lite
Dissolved Acetylene
The Prest-O-Lite Company, Inc.

Oxweld
Apparatus and Supplies
Oxweld Acetylene Company

Units of
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UCC

Sales Offices
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Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.

CHAINS, AUTOMOBILE ENGINE
Link-Belt Co.
Morse Chain Co.

CHAINS, COAL CUTTING
Goodman Mfg. Co.
The Jeffrey Mfg. Co.

CHAINS, DRIVE
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.

CHAINS, FRONT END
Link-Belt Co.
Morse Chain Co.

CHAIN LUBRICANTS
Standard Oil Co. (Ind.)

CHAINS, OILING
Morse Chain Co.

CHAINS, POWER TRANSMISSION
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.

CHAINS, Silent (Bushed-Pin Joint)
Link-Belt Co.

CHAINS, SILENT (Rocker-Joint)
Morse Chain Co.

CHAINS, SLING
Link-Belt Co.
Morse Chain Co.

CHAINS, SPROCKET WHEEL
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.

CIRCUIT-BREAKERS
Westinghouse Electric & Mfg. Co.

CLAMPS, GUARD RAIL
Central Frog & Switch Co.

CLAMPS (Mine)
Westinghouse Electric & Mfg. Co.

CLAMPS (Trolley)
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

CLAMPS, WIRE ROPE
American Steel & Wire Co.
Roebling's Sons Co., J. A.

CLIPS, WIRE ROPE
American Cable Co.
American Steel & Wire Co.
Roebling's Sons Co., J. A.

CLOTH, WIRE
Ludlow Saylor Wire Co.

CLUTCHES
Connellsville Mfg. & Mine Supply Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

COAL CLEANING MACHINERY
American Coal Cleaning Corpn.
Koppers-Rheolaveur Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

COAL COMPANIES
Lehigh Coal & Navigation Co.

COAL CONVEYING MACHINERY
American Coal Cleaning Corpn.
Conveyor Sales Co.
Link-Belt Co.

COAL CRUSHERS
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

COAL CRUSHERS & ROLLS
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.

COAL CUTTERS
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Sullivan Machinery Co.

COAL HANDLING MACHINERY
American Coal Cleaning Corpn.
Conveyor Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.
Westinghouse Electric & Mfg. Co.

COAL LOADERS
Conveyor Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Sullivan Machinery Co.

COAL MINING MACHINERY
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Sullivan Machinery Co.
Westinghouse Electric & Mfg. Co.

COAL MINING PLANTS
American Coal Cleaning Corpn.
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

COAL PREPARATION MACHINERY
American Coal Cleaning Corpn.
Link-Belt Co.
Roberts & Schaefer Co.

COAL SEPARATING MACHINERY
W. S. Tyler Co.

COAL SEPARATORS (Pneumatic)
American Coal Cleaning Corpn.
Roberts & Schaefer Co.

COAL SEPARATORS (Spiralizers)
Link-Belt Co.

COAL TESTING EQUIPMENT
W. S. Tyler Co.

COMPRESSORS, AIR
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.

COMPRESSORS, MINE CAR
Ingersoll-Rand Co.
Sullivan Machinery Co.

CONCENTRATORS (Table)
Allis-Chalmers Mfg. Co.

CONCRETE REINFORCEMENT
American Steel & Wire Co.

CONDENSERS
Allis-Chalmers Mfg Co.
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.

CONTROLLERS
General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

CONVERTERS, COPPER
Allis-Chalmers Mfg. Co.
Westinghouse Electric & Mfg. Co.

CONVEYORS
American Coal Cleaning Corpn.
Conveyor Sales Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

CONVEYOR BEARINGS
Link-Belt Co.

CONVEYORS, BELT
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, CHAIN FLIGHT
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, COAL
American Coal Cleaning Corpn.
Conveyor Sales Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.

CONVEYORS AND ELEVATORS
Allis-Chalmers Mfg. Co.
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, PAN OR APRON
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, SCREW
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

COOLERS (Man)
Robinson Ventilating Co.

COOLERS, ROTARY
Vulcan Iron Works.

COPPER WIRE & STRAND (Bare)
American Steel & Wire Co.
Roebling's Sons Co., J. A.

CORDS—SASH, STEEL WIRE
American Cable Co.

CORE DRILLS, Carbon (Diamonds) for
R. S. Patrick.

CORE DRILLING
Hoffman Bros. Drilling Co.
Pennsylvania Drilling Co.

COUPLINGS, FLEXIBLE
Link-Belt Co.
Westinghouse Electric & Mfg. Co.

CREOSOTE TREATED TIES, TIMBERS, POSTS, PILING, Etc.
Ayer & Lord Tie Co.

CROSSINGS AND CROSSOVERS
C. S. Card Iron Works Co.
Central Frog & Switch Co.
West Virginia Rail Co.

CROSSOVERS
Central Frog & Switch Co.

CROSS TIES, CREOSOTE TREATED
Ayer & Lord Tie Co.

CRUSHER OILS
Standard Oil Co. (Ind.)

CRUSHERS
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.

CRUSHERS (Coal)
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.

CRUSHERS, SINGLE and DOUBLE ROLL
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

CRUSHING PLANTS, COKE
The Jeffrey Mfg. Co.
Link-Belt Co.

CRYSTAL (Quartz)
Diamond Drill Carbon Co.

CUP GREASE
Keystone Lubricating Co.
Standard Oil Co. (Ind.)

CUTTING APPARATUS, Oxy-Acetylene, Oxy-Hydrogen
Oxweld Acetylene Co.

CYCLONE DUST COLLECTORS
American Coal Cleaning Corpn.

DECARBONIZING APPARATUS
Oxweld Acetylene Co.

DESIGNERS OF PLANTS
American Coal Cleaning Corpn.
Koppers-Rheolaveur Co.
Link-Belt Co.
Roberts & Schaefer Co.

DETONATORS
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

DIAMOND CORE DRILL CONTRACTING
Hoffman Bros. Drilling Co.
Sullivan Machinery Co.

DIAMOND DRILLING CARBON
Diamond Drill Carbon Co.
R. S. Patrick.

DIAMONDS, BLACK (See Carbon and Bortz)
Diamond Drill Carbon Co.
R. S. Patrick.

DIAMONDS, INDUSTRIAL
Diamond Drill Carbon Co.
R. S. Patrick.

DIAMOND TOOLS
Diamond Drill Carbon Co.

DIESEL ENGINE OILS
Standard Oil Co. (Ind.)

DIGGERS & PICKS (Pneumatic)
Ingersoll-Rand Co.

DOORS, AUTOMATIC MINE
American Mine Door Co.

DRIFTERS, DRILL
Ingersoll-Rand Co.
Sullivan Machinery Co.

DRILLERS' DIAMONDS
Diamond Drill Carbon Co.

DRILLING CONTRACTORS
Pennsylvania Drilling Co.
Sullivan Machinery Co.

DRILLING, DIAMONDS for
Diamond Drill Carbon Co.
R. S. Patrick.

DRILLS, AIR AND STEAM
Ingersoll-Rand Co.

DRILLS (Blast Hole)
Ingersoll-Rand Co.

DRILL BITS, Carbon (Diamonds) for
Diamond Drill Carbon Co.
R. S Patrick.

DRILL, CARBON (Diamonds) for
Diamond Drill Carbon Co.
R. S. Patrick.

DRILL COLUMNS & MOUNTINGS
Ingersoll-Rand Co.
Sullivan Machinery Co.

DRILL LUBRICANTS
Standard Oil Co. (Ind.)

DRILLER'S DIAMONDS
R. S. Patrick.

DRILLS, CORE
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.

DRILLS, ELECTRIC
General Elcetric Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

DRILLS, HAMMER
Ingersoll-Rand Co.
Sullivan Machinery Co.

DRILLS (Hand Operated Coal)
Ohio Brass Co.

DRILLS, PNEUMATIC
Ingersoll-Rand Co.

DRILLS, PROSPECTING
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.

DRILLS, ROCK
General Electric Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Sullivan Machinery Co.

DRILL STEEL SHARPENERS
Ingersoll-Rand Co.
Sullivan Machinery Co.

DRIVES, SILENT CHAIN
Link-Belt Co.
Morse Chain Co.

DRUMS (Hoisting, Haulage)
Connellsville Mfg. & Mine Supply Co.
Link-Belt Co.
Vulcan Iron Works.

DRY CLEANING COAL & COKE
American Coal Cleaning Corpn.
Link-Belt Co.
Roberts & Schaefer Co.

DRYERS, ROTARY
Vulcan Iron Works.

DUMP CARS
Atlas Car & Mfg. Co.
Connellsville Mfg. & Mine Supply Co.,

DUMPS (Rotary, Cradle, Crossover & Kickback)
C. S. Card Iron Works Co.
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

DUST COLLECTING EQUIPMENT
American Coal Cleaning Corpn.

DUST FILTERS
American Coal Cleaning Corpn.

DYNAMITE
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

DYNAMOS
Allis-Chalmers Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co.

DYNAMO OILS
Standard Oil Co. (Ind)

ELECTRICAL APPARATUS
Allis-Chalmers Mfg. Co.
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

ELECTRICAL CABLES & WIRES
American Steel & Wire Co.
General Electric Co.
Roebling's Sons Co., J. A.

ELECTRIC BLASTING CAPS
Hercules Powder Co.

ELECTRIC HOISTING MACHINERY
Allis-Chalmers Mfg. Co.

ELECTRIC LOCOMOTIVES
General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

ELECTRIC LOCOMOTIVE CABLES
Roebling's Sons Co., J. A.
Westinghouse Electric & Mfg. Co.

ELECTRIC MINE SUPPLIES
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

ELECTRIC WIRES AND CABLES
General Electric Co.
American Steel & Wire Co.

ELECTRICAL SUPPLIES
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

ELECTRICAL WIRES AND CABLES
Roebling's Sons Co., J. A.

ELECTRODES, WELDING
Roebling's Sons Co., J. A.

ELEVATORS
The Jeffrey Mfg. Co.
Link-Belt Co.

ELEVATORS, BUCKET
The Jeffrey Mfg. Co.
Link-Belt Co.

ELEVATOR CABLES & ROPES
Roebling's Sons Co., J. A.

ELEVATOR AND HOIST MOTORS
Westinghouse Electric & Mfg. Co.

ELEVATOR MACHINERY
Atlas Car & Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

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A Superior Speed Reducer for difficult drives
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THESE 30 to 1 ratio gears are transmitting 5 h.p. each from 690 r.p.m. motors to 36 in. apron feeders in a copper smelting plant.
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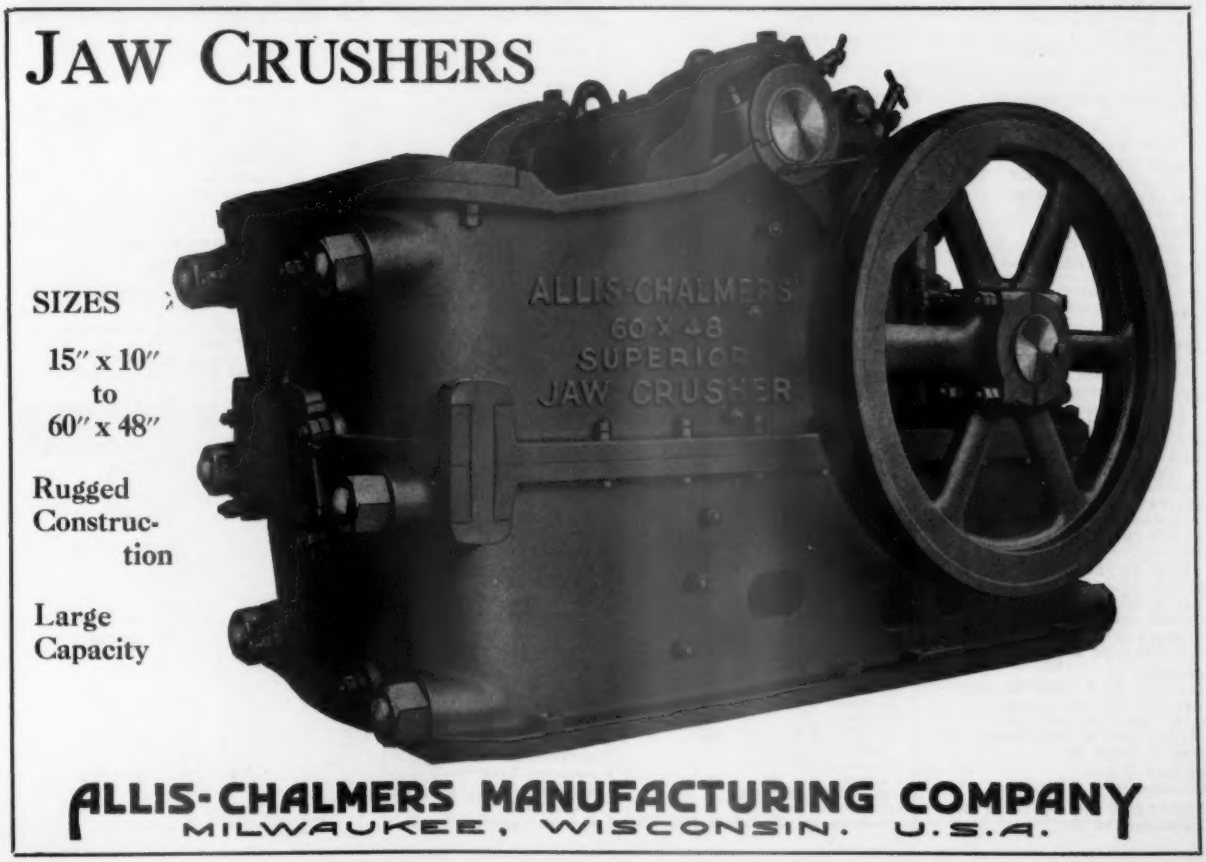
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SIZES
15″ x 10″ to 60″ x 48″
Rugged Construction
Large Capacity
ALLIS-CHALMERS
60 X 48
SUPERIOR
JAW CRUSHER
ALLIS-CHALMERS MANUFACTURING COMPANY
MILWAUKEE, WISCONSIN, U.S.A.

ENGINE OILS
Standard Oil Co. (Ind.)

ENGINES, GAS AND GASOLINE
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.

ENGINES (Hoisting and Hauling)
Connellsville Mfg. & Mine Supply Co.
Westinghouse Electric & Mfg. Co.

ENGINES, OIL
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.

ENGINES, STEAM
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.

EXCAVATORS
Link-Belt Co.

EXHAUSTERS
American Coal Cleaning Corpn.

EXPLOSIVES
The E. I. du Pont Powder Co.
Hercules Powder Co.

FAN DRIVES
Link-Belt Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.

FANS, Man Cooling
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.

FANS, Turbine
Robinson Ventilating Co.
Westinghouse Electric & Mfg. Co.

FANS, VENTILATING
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Robinson Ventilating Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.

FEEDERS
Hockensmith Wheel & Mine Car Co.

FEEDERS (Crossover, Kickback, Rotary and Dump)
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
Roberts & Schaefer Co.

FEEDERS (Gravity)
American Coal Cleaning Corpn.
Link-Belt Co.

FEEDERS (Hand Operated)
Link-Belt Co.
Mining Safety Device Co.
Roberts & Schaefer Co.

FEEDERS, ORE
The Jeffrey Mfg. Co.
Link-Belt Co.

FEEDERS (Reciprocating)
Link-Belt Co.
American Coal Cleaning Corpn.

FEEDERS (Semi-automatic)
Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.

FIBRE GREASES
Standard Oil Co. (Ind.)

FILTER CLOTH, WIRE
Ludlow Saylor Wire Co.

FILTERS (Dust)
American Coal Cleaning Corpn.

FIRE AND WEATHER-PROOF WIRE
Roebling's Sons Co., J. A.

FIRST AID SUPPLIES
Mine Safety Appliances Co.

FITTINGS—WIRE ROPE (Tru-Loc Brand Processed)
American Cable Co.

FITTINGS—WIRE ROPE (Thimbles, Clips, Sockets, Hooks, Shackles Turnbuckles)
American Cable Co.

FLASHLIGHTS AND BATTERIES (Mine Safety)
National Carbon Co., Inc.

FLOTATION MACHINES
Allis-Chalmers Mfg. Co.

FLOTATION OILS
Hercules Powder Co.

FLOW METERS
General Electric Co.

FLUX, WELDING
Oxweld Acetylene Co.

FORGINGS
Allis-Chalmers Mfg. Co.

FROGS
Central Frog & Switch Co.

FROGS AND SWITCHES
C. S. Card Iron Works Co.
Central Frog & Switch Co.
West Virginia Rail Co.

FURNACE OIL
Standard Oil Co. (Ind.)

FURNACES, Oil (for drill steel)
Ingersoll-Rand Co.

FURNACES, ROASTING
Allis-Chalmers Mfg. Co.
Westinghouse Electric & Mfg. Co.

GAS (Cutting, Welding)
Prest-O-Lite Co., Inc.

GAS (Nitrogen, Oxygen)
Linde Air Products Co.

GASOLINE
Standard Oil Co. (Ind.)

GAS ENGINE OILS
Standard Oil Co. (Ind.)

GAS MASKS
Mine Safety Appliances Co.

GAUGES, WELDING & CUTTING
Central Frog & Switch Co.

GAUGE RODS
Central Frog & Switch Co.

GAUGES, WELDING & CUTTING
Oxweld Acetylene Co.

GEAR COMPOUNDS
Standard Oil Co. (Ind.)

GEARS
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

GEARS, BEVEL
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

GEARS (Fabroil & Textolite)
General Electric Co.

GEARS, HERRINGBONE
Link-Belt Co.
Vulcan Iron Works.

GEARS, Machine Cut
Link-Belt Co.
Vulcan Iron Works.

GEARS, Moulded Tooth
Link-Belt Co.
Vulcan Iron Works.

GEARS, Silent Chain
Link-Belt Co.
Morse Chain Co.

GEARS, SPUR
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.

GEARS, WORM
The Jeffrey Mfg. Co.

GELATIN DYNAMITES
E. I. Du Pont de Nemours & Co.
Hercules Powder Co.

GENERATORS AND GENERATING SETS
Allis-Chalmers Mfg. Co.
General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co

GENERATORS, ACETYLENE
Oxweld Acetylene Co.

GLOVES, ASBESTOS
Oxweld Acetylene Co.

GOGGLES, MINERS' WIRE SCREEN, NOD AND SHAKE WELLSWORTH
Mine Safety Appliances Co.

GOGGLES, WELDING
Oxweld Acetylene Co.

GRAPHITE GREASES
Standard Oil Co. (Ind.)

GREASE
Keystone Lubricating Co.
Standard Oil Co. (Ind.)

GREASE CUPS
Keystone Lubricating Co.

GRINDERS, Portable Pneumatic
Ingersoll-Rand Co.

GUARD RAIL CLAMPS
Central Frog & Switch Co.

GUY ROPES, GALVANIZED
American Steel & Wire Co.
Roebling's Sons Co., J. A.

HAMMERS, Calking, Chipping & Riveting
Ingersoll-Rand Co.

HANGERS
Link-Belt Co.

HANGERS (Insulated Trolley)
Ohio Brass Co.

HANGERS, SHAFT, DROP
Link-Belt Co.

HANGERS, SHAFT, POST
Link-Belt Co.

HANGERS, SHAFT, SELF-OILING
Link-Belt Co.

HAULAGE ROPE
American Steel & Wire Co.
Roebling's Sons Co., J. A.

HEADLIGHTS, ARC AND INCANDESCENT
General Electric Co.
Goodman Mfg. Co
The Jeffrey Mfg. Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

HEATER CORD
Roebling's Sons Co., J. A.

HERRINGBONE GEAR DRIVES
Link-Belt Co.

H-H INHALATORS
Mine Safety Appliances Co.

HIGH EXPLOSIVES
E. I. Du Pont de Nemours & Co.
Hercules Powder Co.

HOIST DRIVES
Link-Belt Co.
Vulcan Iron Works.

HOISTING ROPES
American Steel & Wire Co.
Connellsville Mfg. & Mine Supply Co.
Roebling's Sons Co., J. A.

HOISTS
American Steel & Wire Co.
Ingersoll-Rand Co.
Link-Belt Co.
Sullivan Machinery Co.

HOISTS, AIR
Ingersoll-Rand Co.
Sullivan Machinery Co.

HOISTS, ELECTRIC
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
General Electric Co.
Goodman Mfg. Co.
Sullivan Machinery Co.
Vulcan Iron Works

HOISTS, PORTABLE
Ingersoll-Rand Co.
Sullivan Machinery Co.

HOISTS, Room
Vulcan Iron Works.

HOISTS, Room and Gathering
Goodman Mfg. Co.

HOISTS, Scraper-Loader
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.

HOISTS, STEAM
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co.
Vulcan Iron Works.

HOLDERS-ON RIVETING
Ingersoll-Rand Co.

HOOKS
Roebling's Sons Co., J. A.

HOOKS, WIRE ROPE
American Cable Co.

HOSE, AIR AND STEAM
Ingersoll-Rand Co.

HOSE, WELDING AND CUTTING
Oxweld Acetylene Co.

HYDRATORS, LIME
Vulcan Iron Works.

IGNITERS, Electric
Hercules Powder Co.

INCINERATORS
Vulcan Iron Works.

INCLINE FROGS
Central Frog & Switch Co.

INCLINE TRACK LAYOUTS
Central Frog & Switch Co.

INSULATORS, FEEDER WIRE
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

INSULATORS, SECTION
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General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

INSULATORS (Porcelain)
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

INSULATORS (Third Rail)
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Ohio Brass Co.

INSULATORS (Trolley)
General Electric Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

INSULATED WIRE AND CABLE
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General Electric Co.
Roebling's Sons Co., J. A.

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Standard Oil Co. (Ind.)

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Keystone Lubricating Co.

KEYSTONE GREASE CUPS
Keystone Lubricating Co.

KEYSTONE SAFETY LUBRICATORS
Keystone Lubricating Co.

KILNS (Rotary)
Allis-Chalmers Mfg. Co.
Vulcan Iron Works.

KILNS, VERTICAL
Vulcan Iron Works.

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Roebling's Sons Co., J. A.

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Westinghouse Electric & Mfg. Co.

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Carnegie Steel Co.

LIGHT STEEL RAILS
Carnegie Steel Co.
West Virginia Rail Co.

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Joy Manufacturing Co.
Link-Belt Co.

LOADERS (Mine Car)
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Myers-Whaley Co.

LOADERS, PORTABLE
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Myers-Whaley Co.

LOADERS, Snow
Joy Manufacturing Co.

LOADERS, Truck
Joy Manufacturing Co.
Link-Belt Co.

LOADERS, Wagon
Joy Manufacturing Co.
Link-Belt Co.

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Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

LOADING MACHINES
Connellsville Mfg. & Mine Supply Co.
Conveyor Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Myers-Whaley Co.

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Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

LOCOMOTIVES, GASOLINE
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.

LOCOMOTIVES, RACK RAIL
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Goodman Mfg. Co.

LOCOMOTIVES, STEAM
Vulcan Iron Works.

LOCOMOTIVES, STORAGE BATTERY
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General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.

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Roebling's Sons Co., J. A.

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LOCOMOTIVES, TROLLEY
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General Electric Co.
Goodman Mfg. Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.

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Mine Safety Appliances Co.
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Standard Oil Co. (Ind.)
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MILLS, STAMPS
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Hockensmith Wheel & Mine Car Co.
MINE CAR BEARINGS
Hyatt Roller Bearing Co.
Timken Roller Bearing Co.
MINE CAR BOXES
Hockensmith Wheel & Mine Car Co.
MINE CAR FORGINGS
Hockensmith Wheel & Mine Car Co.
MINE CAR LUBRICANTS
Keystone Lubricating Co.
Standard Oil Co. (Ind.)
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Hockensmith Wheel & Mine Car Co.
Phillips Mine & Mill Supply Co.
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Enterprise Wheel & Car Corpn.
Hockensmith Wheel & Mine Car Co.
Phillips Mine & Mill Supply Co.
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Hockensmith Wheel & Mine Car Co.
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Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Westinghouse Electric & Mfg. Co.
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General Electric Co.
Roebling's Sons Co., J. A.
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Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Sullivan Machinery Co.
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Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
MINING MACHINES (Government Approved)
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
MINING MACHINERY
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Westinghouse Electric & Mfg. Co.
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Hyatt Roller Bearing Co.
MINING MACHINERY LUBRICANTS
Keystone Lubricating Co.
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Ayer & Lord Tie Co.
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American Cable Co.
MINING TIMBERS, CREOSOTE TREATED
Ayer & Lord Tie Co.
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MOTORS
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General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co.
MOTORS, Electric
Westinghouse Electric & Mfg. Co.
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Goodman Mfg. Co.
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Roebling's Sons Co., J. A.
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Linde Air Products Co.
OILS
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OXYGEN BREATHING APPARATUS, McCAA TWO-HOUR
Mine Safety Appliances Co.
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Ingersoll-Rand Co.
Sullivan Machinery Co.
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Hercules Powder Co.
PETROLATUMS
Standard Oil Co. (Ind.)
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Roberts & Schaefer Co.
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A. M. Byers Co.
PIPE (Wood)
Connellsville Mfg. & Mine Supply Co.
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American Coal Cleaning Corp.
PNEUMATIC SIZING MACHINERY
American Coal Cleaning Corp.
PNEUMATIC TOOL
Ingersoll-Rand Co.
PNEUMATIC TOOL LUBRICANT
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Central Frog & Switch Co.
PORTABLE TURNOUTS
Central Frog & Switch Co.
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Ayer & Lord Tie Co.
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Hercules Powder Co.
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General Electric Co.
Roebling's Sons Co., J. A.
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Link-Belt Co.
POWER TRANSMISSION MACHINERY
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The Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.
Westinghouse Electric & Mfg. Co.
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Ingersoll-Rand Co.
Pennsylvania Drilling Co.
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PULLEYS, CLUTCH, FRICTION
Link-Belt Co.
PULVERIZERS, COAL AND COKE
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Ingersoll-Rand Co.
PUMPS, AIR LIFT
Ingersoll-Rand Co.
Sullivan Machinery Co.
PUMPS, Boiler Feed
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.
PUMPS, CENTRIFUGAL
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, DEEP WELL
Ingersoll-Rand Co.
PUMPS (Electric)
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
Westinghouse Electric & Mfg. Co.
PUMPS, Fire
Ingersoll-Rand Co.
PUMPS (Gathering or Dip)
Connellsville Mfg. & Mine Supply Co.
PUMPS, Inclined Shaft
Ingersoll-Rand Co.
PUMPS, MINE
Allis-Chalmers Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, Sinking
Ingersoll-Rand Co.
PUMPS, PNEUMATIC AIR LIFT
Ingersoll-Rand Co.
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Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, SAND
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, STEAM
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works).
PUMPS, VACUUM
Ingersoll-Rand Co.
PUNCHES, Drill Steel
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Ayer & Lord Tie Co.
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Ohio Brass Co.
Oxweld Acetylene Co.
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Hyatt Roller Bearing Co.
Timken Roller Bearing Co.
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ROLLS (Crushing)
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The Jeffrey Mfg. Co.
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ROPE GREASE
Keystone Lubricating Co.
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ROPE, SWITCH WIRE
American Cable Co.
ROPE, TOWING WIRE
American Cable Co.
ROPE, TRANSMISSION
American Steel & Wire Co.
Roebling's Sons Co., J. A.
ROPE, WIRE
American Steel & Wire Co.
Roebling's Sons Co., J. A.
ROPE, WIRE (Crescent Brand Ordinary)
American Cable Co.
ROPE, WIRE (Plain or Galvanized)
American Cable Co.
ROPE, WIRE (Tru-Lay Brand Preformed)
American Cable Co.
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Vulvan Iron Works.
ROTARY DRYERS
Vulcan Iron Works.
ROTARY DUMPS
C. S. Card Iron Works Co.
Link-Belt Co.
Mining Safety Device Co.
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Roberts & Schaefer Co.
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RUNNING ROPE, Galvanized
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Allis-Chalmers Mfg. Co.
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C. S. Card Iron Works Co.
The Jeffrey Mfg. Co.
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Roberts & Schaefer Co.
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SCREENS (Vibrating)
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Link-Belt Co.
W. S. Tyler Co.
SCREENS & WASHERIES
Koppers-Rheolaveur Co.
Link-Belt Co.
Roberts & Schaefer Co.
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Ludlow Saylor Wire Co.
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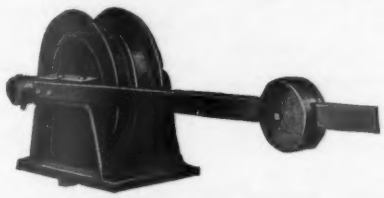

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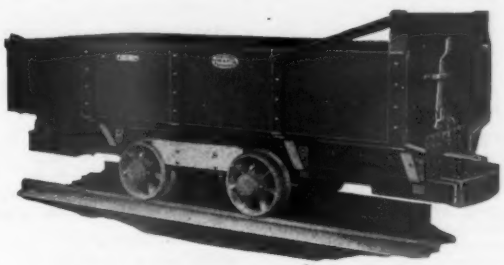

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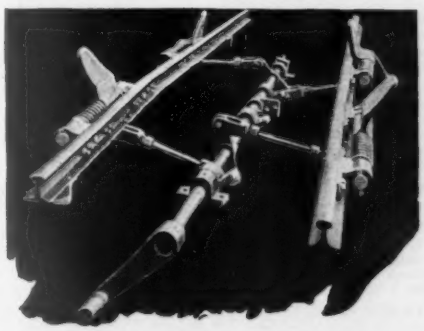

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Morse Chain Co.

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Morse Chain Co.

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West Virginia Rail Co.

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Ohio Brass Co.

SPLICE, INSULATOR
American Mine Door Co.

SPLICE, TROLLEY WIRE
General Electric Co.
Ohio Brass Co.

SPLICERS, TROLLEY
American Mine Door Co.
Ohio Brass Co.
Westinghouse Electric & Mfg. Co.

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Morse Chain Co.

SPROCKETS, COMPENSATING
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Morse Chain Co.

SPROCKETS (Shearing Pin)
Link-Belt Co.
Morse Chain Co.

SPROCKETS, SILENT CHAIN
Link-Belt Co.
Morse Chain Co.

SPROCKETS, SPRING
Link-Belt Co.
Morse Chain Co.

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Carnegie Steel Co.
West Virginia Rail Co.

STEEL, ELECTRIC FURNACE
Timken Roller Bearing Co.

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STEEL, NICKEL
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STEEL, NICKEL, MOLYBDENUM
Timken Roller Bearing Co.

STEEL, OPEN HEARTH
Timken Roller Bearing Co.

STEEL, REINFORCING
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Carnegie Steel Co.

STEEL, Special Analysis
Timken Roller Bearing Co.

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West Virginia Rail Co.

STOPERS, ROCK DRILL
Ingersoll-Rand Co.
Sullivan Machinery Co.

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Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.

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Roebling's Sons Co., J. A.

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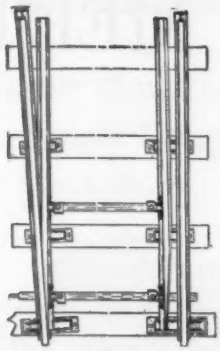
A  REAL STUDY of your operations is essential to a proper track system. The extensive experience of our engineers is at your disposal. Our equipment is of the best materials and can be shipped promptly. Send for free catalog.

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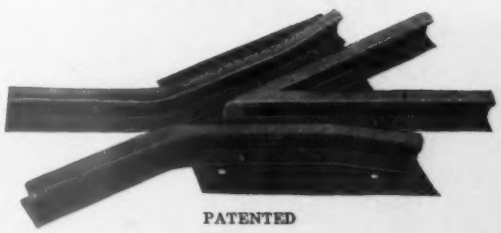

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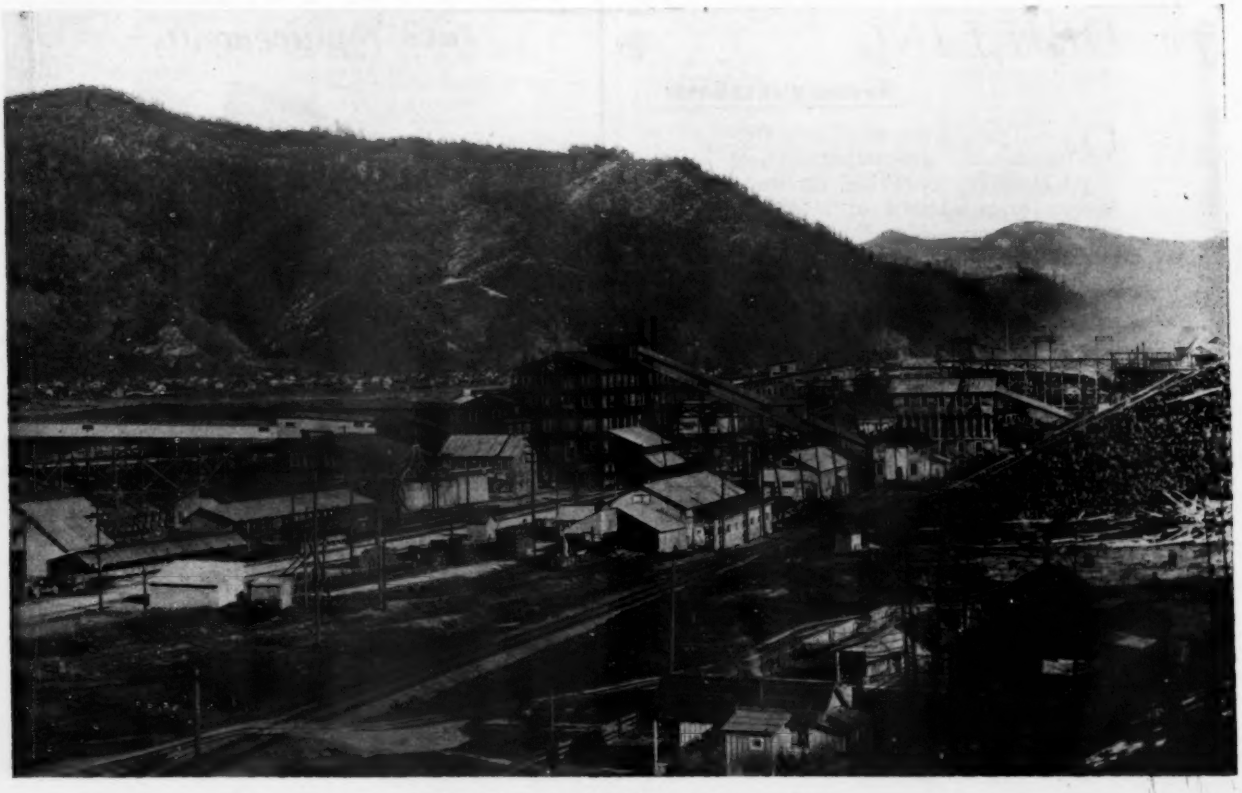

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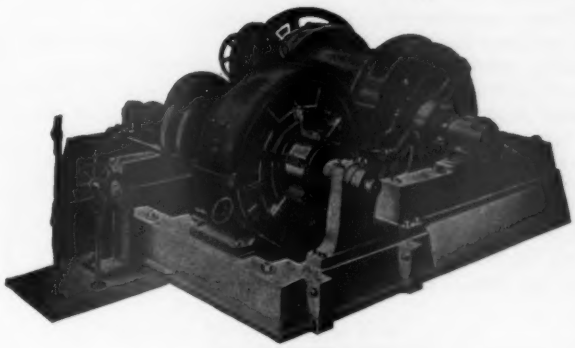

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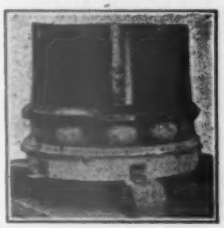

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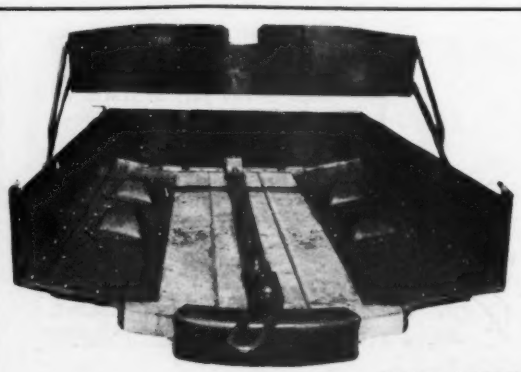

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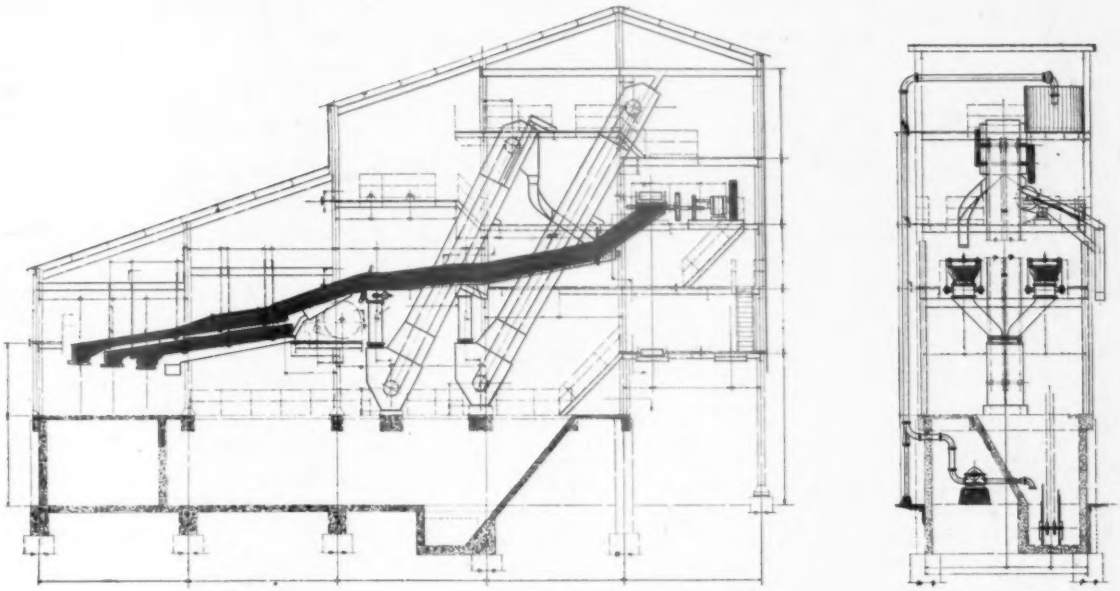

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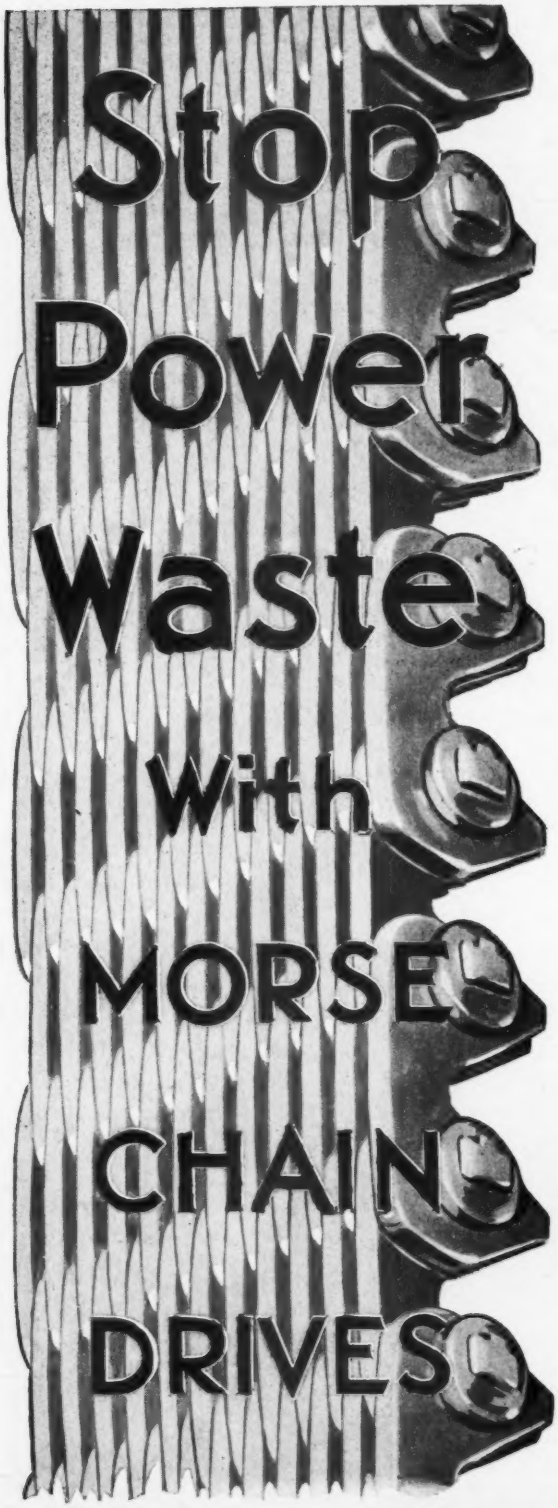

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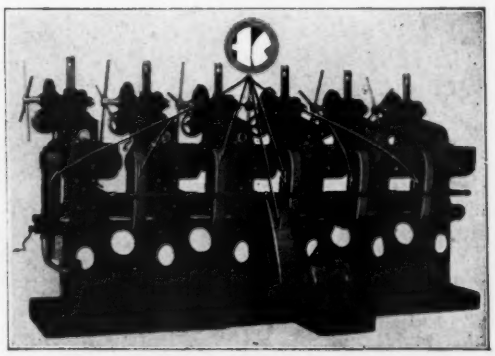

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